# LF sweep generator

# PM 5165

9445 051 65001

## Instruction manual

9499 450 07902

800815/3/01-05

S&I

Scientific & Industrial equipment division

PHILIPS

PHILIPS

# LF sweep generator

# PM 5165

9445 051 65001

Instruction manual
Gerätehandbuch
Mode d'emploi et d'entretien

9499 450 07902
800815/3/01-05

PHILIPS

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**Please note**

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

**Bitte beachten**

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

**Noter s. v. p.**

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

**Important**

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

**Wichtig**

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

**Important**

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisement qualifiés.

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# 1. General information



## 1.1. INTRODUCTION

The LF Sweep Generator PM 5165 produces sinusoidal-, triangular- or square-wave output signals over the frequency range 0.1 Hz to 1 MHz. These signals can be selected to give a sweep of four decades controlled by an internal sweep oscillator or by an external signal.

Pushbutton control of the internal sweep frequency allows single or continuous mode to be selected, and for the signal to be manually held at any point in the sweep; e.g. for further examination of the phenomenon at this frequency or reset of the control signal to the starting frequency.
A 4-digit light-emitting diode display gives digital indication of the output frequency. Indication of frequency range and INTERNAL SWEEP ON is also given by LED's.
The sweep period is adjustable from 1s to 100s.
Three forms of output signal viz: sinewave, triangular- and square-wave are selectable by pushbuttons.
The output signal is continuously variable up to 6 $V_{p\text{-}p}$ and is available on a front-panel BNC-terminal at an impedance of 50 Ω.
A frequency analogue voltage from the sweep oscillator, slewing with 1 V/decade, is available at output socket LOG $f/f_H$ for use with ancillary instruments such as pen recorders.
A PEN LIFT output for X-Y recorder control is provided at the rear of the instrument.

## 1.2. TECHNICAL DATA

**General information**
On delivery from the factory, the instrument complies with the safety regulations of measuring and control equipment. The information and warnings contained in this instruction manual must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

- Only data with indicated tolerances or limits are guaranteed; data without tolerances are given only for guidance.
- All specifications will be met after a warm-up period of 30 min. when keeping the instrument in a constant mounting position.
- Inaccuracies (absolute or in %) relate to the indicated reference value.

SPECIFICATIONS

**Frequency**

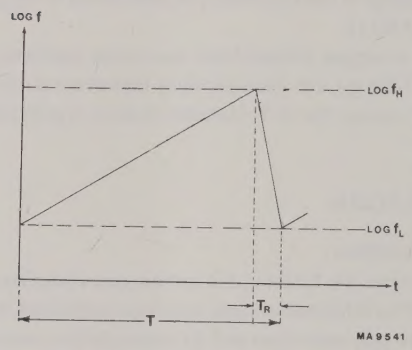
| | |
|---|---|
| Nominal range | 0.1 Hz to 1 MHz |
| Selected ranges | 0.1 Hz ... 1 kHz<br>10 Hz ... 100 kHz<br>100 Hz ... 1 MHz |
| Adjustment | –three range pushbuttons, FREQ MULTIPL x0.01, x1, x10<br>–coarse control knob FREQUENCY $f_H$ Hz with logarithmic scale from 10 to 100 k<br>–fine control knob FREQUENCY $f_H$ Hz with linear scale, x0,9 to x1.1 |
| Display | Digit LED display (3½ digits) with automatic range-changing (decimal points and range lamps) |
| Display accuracy | ± 1 % ± 1 digit at reference operating conditions. |
| Display temperature coefficient | < 0.1 %/°C |

**Sweep control function**

| | |
|---|---|
| – OFF | Preset state for the upper frequency limit $f_H$ of the sweep range.<br>$f_H$ is indicated by the FREQUENCY display.<br>External frequency sweep is possible. |
| – HOLD | Stopping at the instantaneous frequency during internal sweep. |
| – START | Triggering a single sweep period |
| – CONTINUOUS | Internal periodically repeating sweep cycles |
| – RESET | Resetting from the instantaneous frequency during internal sweep to $f_L$ |
| – SET $f_L$ | Preset state for the lower frequency limit $f_L$ of the sweep range |
| – BLANKING | Suppression of the output signal during sweep flyback |

**Internal frequency sweep**

Sweep characteristic: Logarithmic




T = Sweep period
$T_R$ = Sweep flyback
$f_L$ = lower frequency limit of the sweep range
$f_H$ = upper frequency limit of the sweep range

| | |
|---|---|
| Sweep ratio $f_H/f_L$ | 1 to $10^4$, continuously adjustable in the sweep preset state SET $f_L$ |
| Sweep period | 1 to 100s, continuously adjustable |
| Flyback | 80 ... 200 ms |

**LOG $f/f_H$ output**

| | |
|---|---|
| | BNC socket |
| Output voltage | – 4 V ... 0 V, 1 V/frequency decade; positive going with increasing frequency, approximating 0 when arriving at $f_H$ |
| Internal resistance | 1 k Ω |
| Max. current | 4 mA |

**Pen lift output**

BNC socket

(rear of instrument)

Adapted to X-Y recorders;
PHILIPS PM 8041, PM 8125 PM 8132 and PM 8141

| | | |
|---|---|---|
| Max. current | 0.5 A | electronic switch closed |
| Output voltage | < 0.7 V | |
| Output voltage | +15 V | electronic switch opened |
| Internal resistance | 15 KΩ | |

| | |
|---|---|
| **Control input SWEEP IN** | BNC socket |
| Sweep ratio $f_H/f_L$ | 1 to $10^4$, depending of the control voltage on input SWEEP IN |
| Input impedance | 10 k$\Omega$ //1 nF |
| Sensitivity | 1 frequency-decade/V<br>With a position going control voltage the frequency increases. |
| Maximum input voltage | ± 20 V |
| Maximum sweep frequency | 400 Hz approx. with time-symmetrical triangular control voltage |
| Maximum modulation frequency for FM (small deviations) | 2 kHz |
| **Signal OUTPUT** | BNC socket |
| Internal impedance | 50 $\Omega$ |
| Signal waveforms | time-symmetrical sine, triangular or square |
| Open circuit output voltage | 0,07 to 6 $V_{p-p}$, continuously adjustable |
| Load capability | short-circuit proof |
| *Sinewave* | |
| Amplitude response (reference value 1 kHz) | < 1 % up to 100 kHz<br>< 3 % up to 1 MHz |
| Distortion | < 0.5 %, typically 0.2 %, up to 100 kHz with FREQ MULTIPL in positions x0.01 and x1<br>< 2 % up to 1 MHz, typically 0.4 % with FREQ MULTIPL in position x10 |
| *Squarewave* | |
| Risetime and falltime | < 60 ns, typically 50 ns |
| Overshoot and ringing | < 2 % |
| D.C.-offset | < 50 mV at max. amplitude |

## ENVIRONMENTAL CONDITIONS

The environmental data are valid only if the instrument is checked in accordance with the official checking procedures.
Details on these procedures and failure criteria are supplied on request by the PHILIPS Organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

| | |
|---|---|
| **Ambient temperature** | |
| Reference value | 23 °C ± 1 °C |
| Nominal working range | +5 to +40 °C |
| Limits for storage and transit | −40 to +70 °C |
| **Relative humidity** | |
| Reference range | 45 to 75 % |
| Nominal working range | 20 to 80 % |
| **Air pressure** | |
| Reference value | 1013 mbar (≙760 mm Hg) |
| Nominal working range | up to 2200 m height (800 to 1066 mbar) |
| **Air speed** | |
| Reference value | 0 to 0.2 m/s |
| Nominal working range | 0 to 0.5 m/s |

| | |
|---|---|
| **Operating position** | Optional |
| **Power supply** | a.c. mains |
| Reference value | 230 V |
| Nominal values | 115/230 V |
| Nominal operating range | ± 15 % of the selected nominal value |
| Frequency range | 50 to 100 Hz |
| — tolerance | ± 5 % |
| Consumption | 27 W |
| Warming-up period | 30 min. |

CABINET

| | |
|---|---|
| Protection class (see IEC 348) | Class I, protective conductor |
| Protection type (see IEC 144) | IP 20 (see DIN 40 050) |
| Overall dimensions | |
| — height | 145 mm |
| — width | 240 mm |
| — depth | 300 mm |
| Weight | approx. 3.5 kg |

## 1.3. ACCESSORIES

| | |
|---|---|
| Standard accessories | Instruction manual |
| Optional accessories | PM 9585 : 50 Ω termination 1 W<br>PM 9075 : Coaxial connection cable BNC-BNC |

## 1.4. DESCRIPTION OF THE BLOCKDIAGRAM (fig. 1)

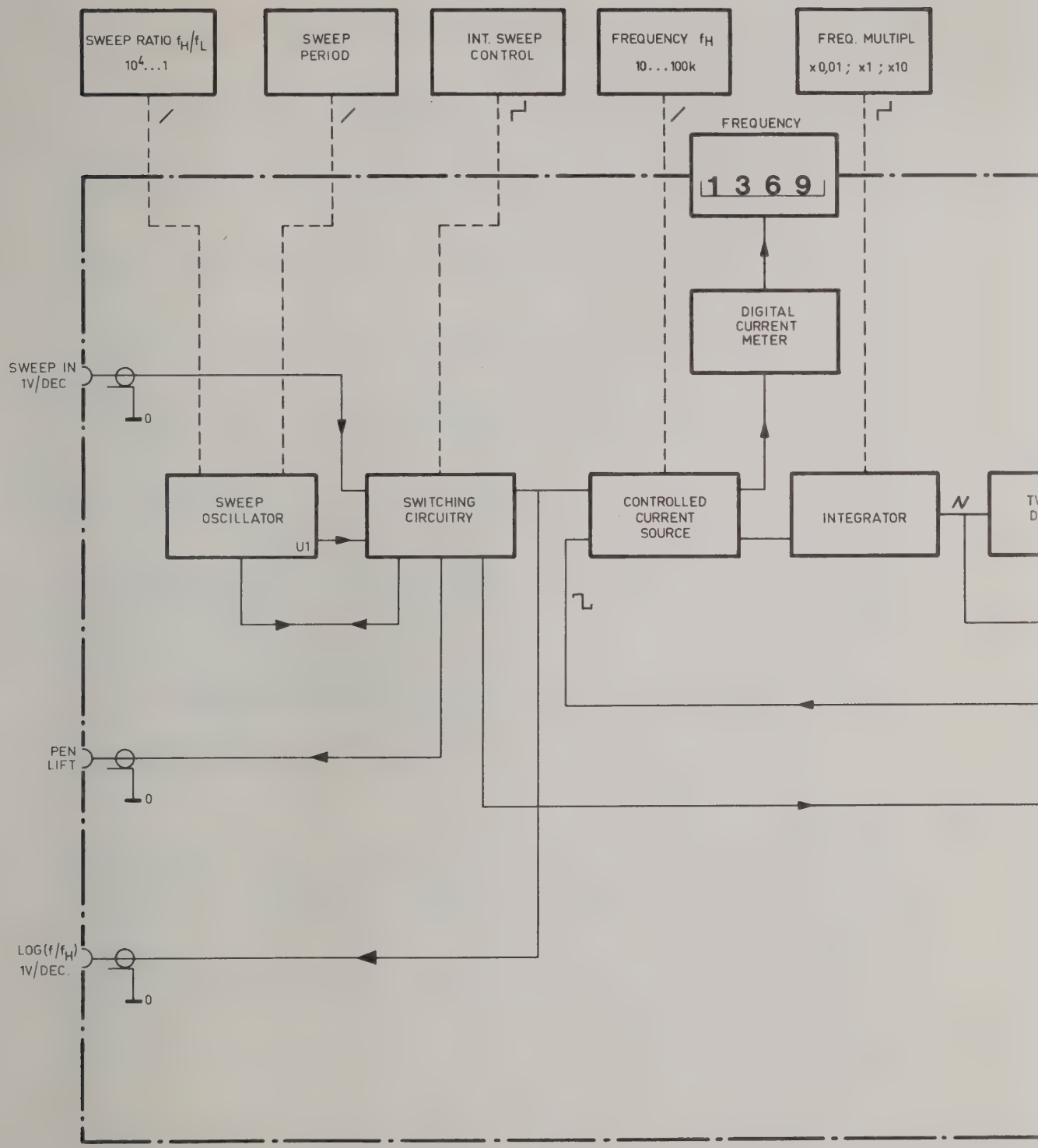
The main oscillator part of the generator is formed by a CONTROLLED CURRENT SOURCE, an INTEGRATOR and a TWO- LEVEL DETECTOR or comparator circuited in a closed loop. The CONTROLLED CURRENT SOURCE functions as a voltage/current converter, which produces the load current for the INTEGRATOR. The load current polarity is controlled by the TWO-LEVEL DETECTOR. In this way at the INTEGRATOR output a time-symmetrical triangular wave and at the TWO-LEVEL DETECTOR output a time-symmetrical squarewave arises.

The frequency of the oscillator is determined by the control voltage at the CONTROLLED CURRENT SOURCE input, the frequency control FREQUENCY $f_H$ Hz and the range switches FREQ MULTIPL. The frequency is indicated by the LED display FREQUENCY. Therefore, the DIGITAL CURRENT METER comprises the necessary measuring circuitry.
The control voltage is supplied either from the internal SWEEP OSCILLATOR or from the external control input SWEEP IN.
Change-over is achieved in the SWITCHING CIRCUITRY by means of the INT SWEEP CONTROL switches.
The respective control voltage supplied to the CONTROLLED CURRENT SOURCE is simultaneously available at output LOG $f/f_H$.
The range for the internal sweep by the SWEEP OSCILLATOR can be determined by means of control SWEEP RATIO $f_H/f_L$. The sweep period is adjustable with control SWEEP PERIOD.

Via the BLANKING SWITCH, the ATTENUATOR and the OUTPUT AMPLIFIER the triangular or squarewave signal from the main oscillator, selectable by the WAVEFORM switch, is routed to the signal OUTPUT. In the position ~ of the WAVEFORM switch the triangular wave is supplied to the SINE SHAPER and via the before mentioned signal path to the OUTPUT socket.
During the sweep-fly-back the BLANKING SWITCH interrupts the signal path. The BLANKING SWITCH is controlled by the SWITCHING CIRCUITRY.
With control AMPLITUDE the amplitude of the output signal is continuously adjustable.

The PEN-LIFT output is connected to an electronic switch in the SWITCHING CIRCUITRY, which is opened during sweep-flyback.

The interference free power supply provides stabilised d.c. voltages for the various circuits.


SWEEP RATIO $f_H/f_L$
$10^4 \ldots 1$
SWEEP PERIOD
INT. SWEEP CONTROL
FREQUENCY $f_H$
10 . . . 100k
FREQ. MULTIPL
x0,01 ; x1 ; x10
FREQUENCY
1 3 6 9
DIGITAL CURRENT METER
SWEEP IN 1V/DEC
0
SWEEP OSCILLATOR
U1
SWITCHING CIRCUITRY
CONTROLLED CURRENT SOURCE
INTEGRATOR
N
PEN LIFT
0
LOG(f/$f_H$) 1V/DEC.
0

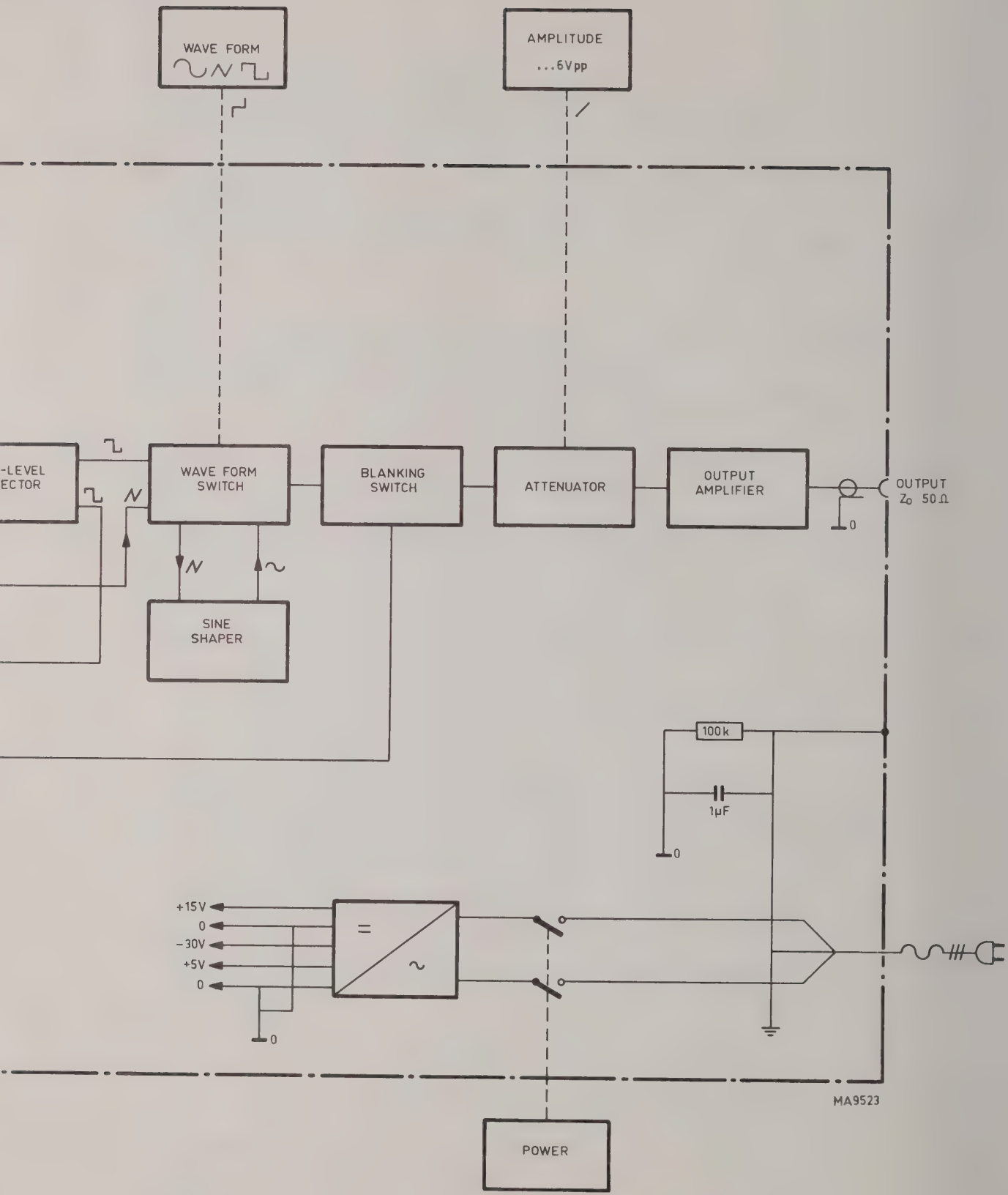



Fig. 1. Block diagram PM 5165

# 2. Installation

## 2.1. SAFETY REGULATIONS (see IEC 348 or VDE 0411)

Before connecting the instrument to the mains, visually check the cabinet, controls and connectors etc., to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the instrument to the mains. Always disconnect the instrument from the mains before removing any protective covers.
Any maintenance and service work necessary with the instrument switched on, should only be performed by a qualified technician.
The mains connector must only be plugged into an earthed mains socket.
Do not make this safety protection ineffective; for example, by use of an extension cable without protective conductor.

## 2.2. POSITION

The instrument may be used in any position. By tilting the handle the instrument may be used in sloping position.
Ensure that the ventilation holes in top and bottom plates are free from obstructions.
Do not position the instrument on any surface which produces or radiates heat or in direct sunlight.

## 2.3. EARTHING

Before switching on, the instrument must be earthed in conformity with the local safety regulations, via the three-core mains cable.
(See also section 2.1. "Safety regulations").
The circuit earth potential of the generator (that of the external contacts of all BNC connectors) is connected to the cabinet by means of a parallel-connected capacitor and resistor. Correct HF-earthing of the circuit is then obtained.
The outer contacts of the BNC-sockets must not be used to connect a protective conductor.

**WARNING:** Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.
When an instrument is brought in from a cold environment for use in a warm room condensation may cause a hazardous condition. Therefore, ensure that the earthing requirements are strictly adhered to.

## 2.4. ADJUSTMENT OF MAINS VOLTAGE; MAINS CONNECTION

Before inserting the mains plug into the mains socket, ensure that the instrument is set to the local mains voltage. The instrument must be connected only to an a.c. supply. On delivery the instrument is set to 230 V ± 15 %. If the instrument is to be used on 115 V supply, proceed as follows:

- unplug the mains connector
- loosen the two screws at the rear to remove the base plate
- change the connections on the mains transformer primary in accordance with the indication on Unit 3 and fig. 2.
- change the mains voltage indication plate at the rear of the instrument in accordance with the mains voltage selected
- replace the covers.

Fig. 2. Connection diagram for the different mains voltages

*Fuse replacement*

Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of repaired fuses must be avoided. The instrument must be disconnected from all voltage sources when a fuse is to be replaced.
Internal mains adjustment and fuse replacement must only be undertaken by a skilled person who is aware of the hazards involved.

# 3. Operating instructions

## 3.1. CONTROLS AND SOCKETS (fig. 3 and 4)

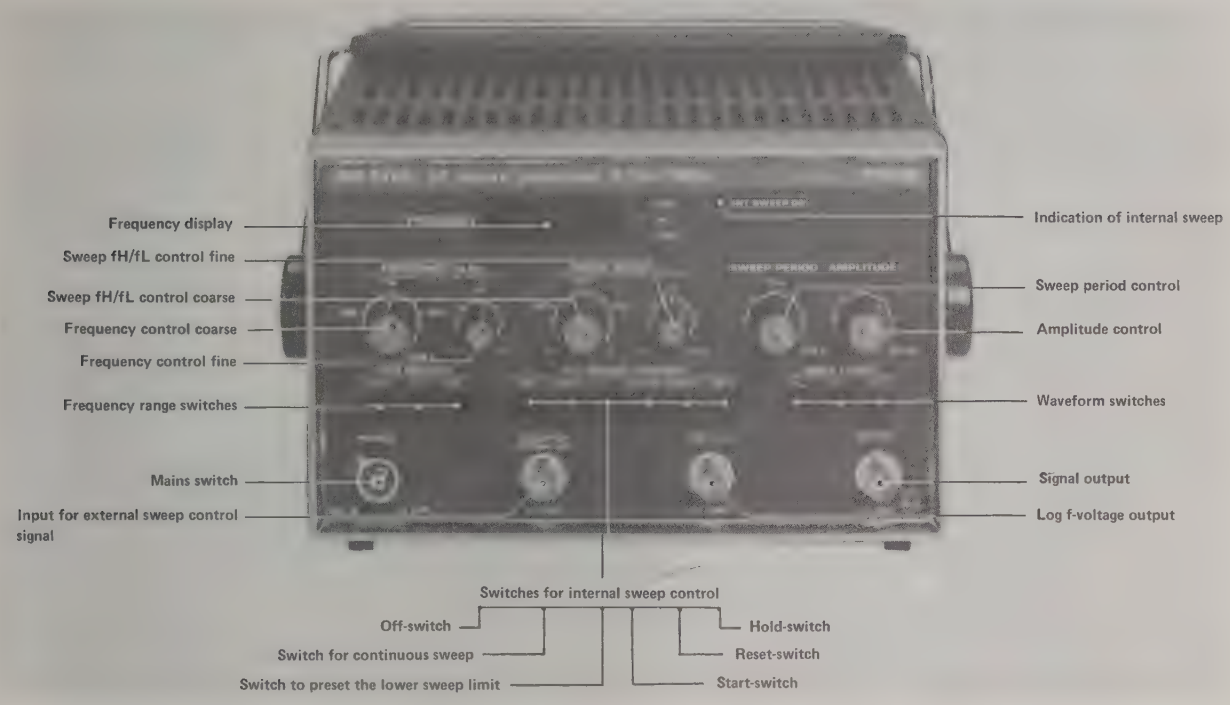



Fig. 3. Controls and sockets, front panel

Fig. 4. Controls and sockets, rear panel

## 3.2. OPERATION

### 3.2.1. Switching on the instrument

After the sweep generator has been connected to the mains in accordance with sections 2.3. and 2.4. it may be switched on by depressing the mains switch, POWER.
The white spot inside the POWER switch indicates mechanically that the instrument is switched on.
However, to meet the specifications, the instrument should be allowed a warm-up period of 30 minutes in a constant position.

### 3.2.2. Setting the waveform and the amplitude

The required output waveform can be selected by operation of the relevant WAVEFORM pushbutton ( ∼ , ⋀ or ⊓ ).
The signal amplitude at the OUTPUT BNC socket is continuously adjustable by means of the AMPLITUDE control to values between 0.07 and 6 $V_{p\text{-}p}$.

### 3.2.3. Setting the upper sweep range limit $f_H$

The frequency $f_H$, is adjusted in the INT SWEEP CONTROL OFF mode.
Therefore the related pushbutton must be depressed.
In the pre-conditioned operational mode INT SWEEP CONTROL OFF, $f_H$ is the actual frequency of the generator OUTPUT signal.
For internal sweep $f_H$ is the upper limit of the sweep range. If sweeping externally $f_H$ is the resulting output frequency in case of 0 V input voltage on SWEEP IN.

Three controls are provided for setting the upper frequency limit of the sweep:

1. coarse control FREQUENCY $f_H$ Hz, with logatithmic scale
2. range selector pushbutton FREQ MULTIPL
3. fine control FREQUENCY $f_H$ Hz (x0.9 to x1.1)

If the required nominal frequency is set by the above mentioned controls the resulting frequency equals the product at the $f_H$-scale readings and the multiplier factor of the frequency range selector (e.g. a scale reading of 1 K x1 and a range selector x10 gives an output frequency of 10 kHz).
Furthermore, this frequency is precisely indicated by the display FREQUENCY.

### 3.2.4. Setting the lower sweep range limit $f_L$

After ensuring that $f_H$ displays the correct frequency (section 3.2.3), depress the INT SWEEP CONTROL pushbutton SET $f_L$ and adjust the SWEEP RATIO controls to the low frequency ($f_L$) limit required, indicated by the display.

The following controls are provided for setting the lower frequency limit:

1. coarse control SWEEP RATIO $f_H/f_L$, with logarithmic scale
2. fine control SWEEP RATIO $f_H/f_L$ (x1.1 to x0.9)

Because these controls are relative ones the setting of $f_L$ depends on the setting of $f_H$, e.g., if the adjusted sweep ratio is $10^2$ and $f_H$ is 100 kHz the resulting $f_L$ is 1 kHz.
$f_L$ means the lower frequency range limit for internal sweep, both for continuous or single sweep.
After initiating the sweep by depressing the START or CONT pushbutton (section 3.2.5.) the sweep starts at $f_L$ and the frequency will increase exponentially up to $f_H$.

Example: If the upper limit ($f_H$) is 20 kHz and it is required to sweep the audio frequency band then a sweep ratio of three decades is required. With the SWEEP RATIO set to $10^3$ a low frequency limit of 20 Hz will be displayed.

i.e. $\frac{f_H}{f_L} = 10^3$ or

$$f_L = \frac{f_H}{10^3} = \frac{20.000\ \text{Hz}}{10^3} = 20\ \text{Hz}$$

### 3.2.5. Internal sweep mode

Having set the sweep limits (sections 3.2.2., 3.2.3., 3.2.4.), the generator is prepared for use either in the single-shot or continuous mode.

Single-shot sweep may be started by depressing the INT SWEEP CONTROL "START" pushbutton. The frequency of the output will make a single sweep from the lower limit $f_L$ to the upper limit $f_H$ and then return to the lower limit $f_L$, at a time determined by the SWEEP PERIOD control setting, where it will be held by the switching logic until the START button is actuated again.

During sweep-flyback the output signal is blanked. Additionnally the electronic switch of the PEN LIFT output is opened.

Continuous sweep may be selected by depressing the INT SWEEP CONTROL "CONT" pushbutton. The frequency of the output will periodically sweep from the lower limit $f_L$ to the upper limit $f_H$ and flyback. The sweep cycle period is determined by the SWEEP PERIOD control setting.

Actuation the RESET control pushbutton allows for immediate return at any point during sweep to the lower frequency limit $f_L$.

The HOLD control pushbutton can be used during a sweep to enable any chosen instantaneous frequency to be held for examination, whilst the pushbutton is depressed.

### 3.2.6. External sweep mode

The INT SWEEP CONTROL "OFF" must be depressed.

The frequency of the generator can be controlled by supplying an external voltage to the SWEEP IN coaxial socket.

The frequency of the generator, indicated by the display, changes exponentially with the control voltage (1 V/decade) following the relation:

$$f_o = f_H \cdot 10^{\frac{U_c}{V}}$$

where; $f_o$ = instantaneous signal frequency of the generator output

$f_H$ = preset value indicated by the display

$U_c$ = control voltage at input SWEEP IN

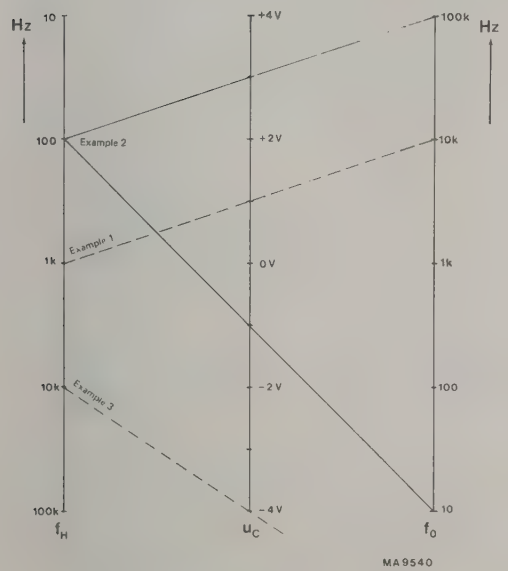
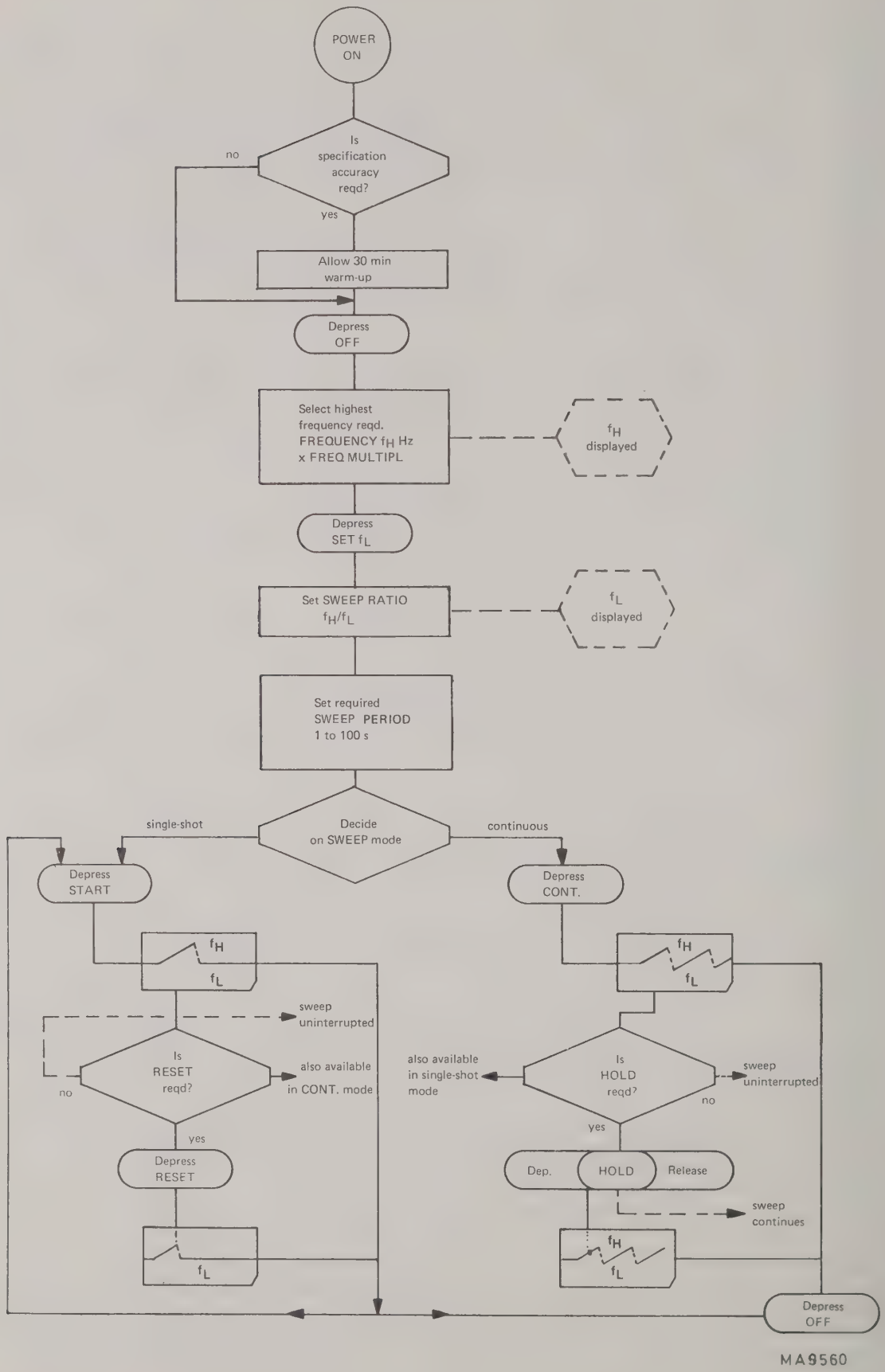



Fig. 5. Sweep range PM 5165

| | | |
|---|---|---|
| Example 1: | $f_H$ set to | 1 k . factor B |
| | Control voltage $U_c$ | +1 V |
| | Output frequency $f_o$ | (1 k . factor B . $10^{+1}$) Hz |
| Example 2: | $f_H$ set to | 100 . factor B |
| | Control voltage $U_c$ | 4 $V_{p\text{-}p}$ triangular wave, superimposed on a d.c. voltage of 1 V |
| | Output frequency $f_o$ | Continuous between the limits (100 . factor B . $10^{+3}$) Hz and (100 . factor B . $10^{-1}$) Hz |
| Example 3: | $f_H$ set to | 10 k . factor B |
| | Control voltage $U_c$ | −4 V |
| | Output frequency $f_o$ | not defined |

The value indicated for $f_H$ must be multiplied by the value of the FREQ MULTIPL Switch depressed (factor B).

### 3.2.7. Flow chart of internal frequency sweep procedure



## 3.3. RECORDING OF THE FREQUENCY RESPONSE OF HiFi EQUIPMENT

Conventional measuring methods, in which a frequency characteristic is plotted by point-by-point measurements, are much too cumbersome and time-consuming for use in the development and testing of modern HiFi equipment.

Dynamic measuring methods making use of square-wave signals give results quickly, but the accuracy is not too high. However, they are useful e.g. for comparison of the transmission properties of the two channels of a stereo amplifier or for rapid diagnosis of amplitude and phase errors.

Where measurements which are both rapid and accurate are called for, a different measuring set-up is required. We describe here a set-up making use of two new Philips instruments, the sweep generator PM 5165 and the Amplifier AC/DC logarithmic converter PM 5171, together with an X-Y recorder such as the PM 8041, which gives excellent results in this field of application. In view of the wide bandwidth and amplitude ranges to be covered, it is desirable to record the frequency characteristic with logarithmic scales along both axes. The PM 5165 and PM 5171 are ideal in this connection, as they are both provided with logarithmic outputs.

### THE MEASURING SET-UP

The block diagram of the measuring set-up is shown in Fig. 6.

The sweep generator PM 5165 delivers a sinusoidal signal of constant amplitude, the frequency of which is swept logarithmically in the range from 13 Hz up to 100 kHz. This signal is applied to the R input of the stereo amplifier. The L input is terminated with an RC network (47 kohm//220 pF), the impedance of which corresponds to the internal impedance of a source such as might be encountered in practice. The outputs of the amplifier under test are each terminated with a 4.7 ohm impedance.

The sweep generator drives the X input of the X-Y recorder PM 8041 via its LOG $f/f_H$ output, so that the excursion of the pen of the recorder in the X direction is proportional to the logarithm of the frequency of the sinusoidal signal.

The voltage drop across the 4.7 ohm load resistor is used to drive the PM 5171. The latter has three outputs: amplifier, AC-to-DC conv. (linear output) and LOG CONV. In this application, the LOG CONV output is connected to the Y input of the X-Y recorder, while the AMPLIFIER output can be connected to an oscilloscope for checking the waveform of the signal. When the amplitude range to be covered is relatively narrow, the Y input of the recorder can be connected to the linear output of the PM 5171; this thus gives a choice between a logarithmic and linear excursion of the pen of the recorder.

### APPLICATION

#### Recording the amplitude response

Fig. 7 shows the amplitude response plotted as a function of the frequency. The advantage of using logarithmic scales in both the X and Y directions becomes very clear here.

These curves are recorded with the setting of the tone controls as parameter. It will be seen that the setting of the tone controls has hardly any influence on the amplitude at mid-range frequency.

For further information on the recording conditions, see fig. 7.

The amplitude response of the other channel may be recorded in the same way, and the two sets of curves compared as described below.

#### The effect of tone-compensated volume control

This is shown in Fig. 8. In this case, the output amplitude of the stereo amplifier is used as parameter instead of the tone-control setting. The measuring set-up is the same as for Fig. 6. It will be seen that there is a dip in the middle of the response curves at lower volumes. This is just what we want, as it corresponds to the frequency response curve of the human ear.

During the recording of these curves, the tone controls were set at an intermediate position.

**Comparison of amplitude responses**

Fig.11 shows the amplitude response curves for the two channels, with the BALANCE control of the stereo amplifier shifted slightly from its mid-way position.
The Y sensitivity of the recorder is increased, in order to bring out the difference between the two curves more clearly.
The tone controls of the stereo amplifier are set to there mid-way position.

The bottom curve in this figure is for the L channel, with the BALANCE control set so that both channels give the same output level at 50 Hz.

**Cross-talk**

Fig.12. shows the cross-talk from the R channel to the L channel. The Y sensitivity of the recorder is reduced for this measurement, and the input of the L channel is bypassed with an impedance of 47 kohm//220 pF (see Fig.8). The top curve shows the amplitude response of the R channel with a power dissipation of 6.7 W and the tone controls set to their mid-way position, while the third curve from the top shows the amplitude response of the L channel under these conditions, due to cross-talk from the R channel. Similarly, the second curve from the top is for the R channel with an output power of 0.1 W, while the bottom of the curve shows the cross-talk in the L channel under these conditions.

It will be seen from this figure that the cross-talk is frequency-dependent, varying from about 30 to 50 dB as a function of the frequency in the range from 50 Hz to 15 kHz. The cross-talk increases quite strongly at frequencies above 10 kHz, but this does not matter very much as the amplitude at these frequencies are relatively low, in the reproduction of music.

The cross-talk is minimum at mid-frequency. The rise in cross-talk at low frequencies is caused by the limited resistance of the common power supply, while that at high frequencies is due to the presence of stray capacitances and inductances;

To connect the PEN LIFT output of the PM 5165 correctly to PHILIPS X-Y recorders, use the table below:

| *PM 5165 (rear side)* | *BNC-socket Centre connection (+15 V)* | *BNC-socket Outer connection (signal earth)* |
|---|---|---|
| PM 8041 (Bottom side) | Amphenol plug connection 2 | Amphenolplug connection 1 |
| PM 8125 | BU101 connection 2 | BU101 connection 1 |
| PM 8132 | 24-pole plug connection 11 | 24-pole plug connection 21 or 22 |
| PM 8141 | Amphenol plug connection 2 | Amphenol plug connection 1 |

For connection of the PEN LIFT output to other X-Y recorders, refer to the service manual of the manufacturer.

# 1. Allgemeines

## 1.1. EINLEITUNG

Der NF Sweep-Generator PM 5165 erzeugt sinus-, dreieck- und rechteckförmige Ausgangssignale im Frequenzbereich von 0,1 Hz bis 1 MHz.
Diese Signale sind über einen Sweepbereich von vier Dekaden steuerbar. Die Steuerung erfolgt entweder durch den internen Sweeposzillator oder mit einem externen Signal.

Mit den Drucktasten für die interne Sweepsteuerung kann ein einmaliger oder kontinuierlicher Ablauf eingestellt werden. Ausserdem kann während des Sweeps die Ausgangsfrequenz bei jedem beliebigen Momentanwert festgehalten oder auf den Anfangswert zurückgesetzt werden.

Mit einer vierstelligen Leuchtdiodenanzeige wird die Ausgangsfrequenz digital angezeigt. Ferner wird der interne Frequenzablauf (INT SWEEP ON) mit einer Leuchtdiode angezeigt.

Die Periodendauer ist von 1 s bis 100 s stetig einstellbar. Die drei Ausgangssignalformen, nämlich Sinus, Dreieck und Rechteck sind mit Drucktasten wählbar. Das Ausgangssignal ist bis zu 6 V (Spitze-Spitze) stetig einstellbar und steht am Signalausgang OUTPUT mit einer Impedanz von 50 Ω zur Verfügung.

Zur Steuerung von X-Y-Schreibern steht eine frequenzanaloge Gleichspannung (1 V/Dekade) an der Buchse LOG ($f/f_H$) und ein PEN LIFT-Anschluß an der Rückseite des Geräts zur Verfügung.

## 1.2. TECHNISCHE DATEN

Allgemeine Hinweise

Dieses Gerät entspricht den Sicherheitsbestimmungen für elektrische Meß- und Regeleinrichtungen und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muß der Anwender die Hinweise und Warnvermerke beachten, die in dem vorliegenden Gerätehandbuch enthalten sind.

- Nur Angaben mit Toleranzen oder Grenzwerten können als garantierte Daten angesehen werden. Daten ohne Toleranzen, d. h. ohne Fehlergrenzen, sind informative Daten und werden nicht garantiert.
- Fehlerangaben gelten nach einer Anwärmzeit von 30 Minuten nach dem Einschalten bei konstanter Betriebslage.
- Prozentuale und absolute Fehler sind auf den jeweils angegebenen Referenzwert bezogen.

KENNGRÖSSEN

**Frequenz**

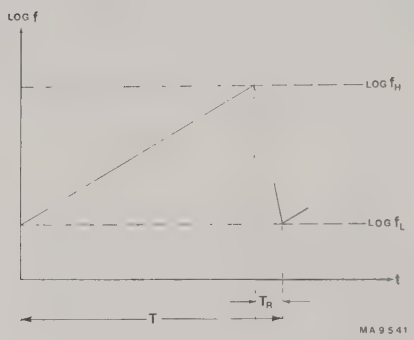
| | |
|---|---|
| Nennbereich | 0,1 Hz bis 1 MHz |
| Teilbereiche | 0,1 Hz ... 1 kHz<br>10 Hz ... 100 kHz<br>100 Hz ... 1 MHz |
| Einstellelemente | – drei Bereichstasten FREQ. MULTIPL. x0.01, x1, x10<br>– Frequenzeinsteller grob FREQUENCY $f_H$ Hz mit logarithmischer Skala von 10 bis 100 k<br>– Frequenzeinsteller fein FREQUENCY $f_H$ Hz mit linearer Skala von x0.9 bis x1.1 |
| Frequenzmesser | Digitale Leuchtdiodenanzeige (3½ Digits) mit automatischer Bereichsumschaltung und Gleitkomma (und Bereichslämpchen) |
| – Fehlergrenzen | ± 1 % ± 1 Digit bei Referenz-Umgebungsbedingungen |
| – Temperaturkoeffizient | < 0,1 %/°C |

**Sweep-Steuerfunktionen**
INT SWEEP CONTROL

- OFF : Betriebsart zum **Einstellen** der **oberen** Frequenzgrenze $f_H$ des Sweepbereichs, angezeigt von der Leuchtdiodenanzeige FREQUENCY. Externe Frequenzsteuerung ist möglich.
- SET $f_L$ : Betriebsart zum Einstellen der **unteren** Frequenzgrenze $f_L$ des Sweepbereichs, angezeigt von der Leuchtdiodenanzeige FREQUENCY
- CONT : Auslösen des sich periodisch wiederholenden Sweepablaufs
- START : Auslösen einer einzelnen Sweepperiode
- RESET : Rücksetzen während des internen Sweepablaufs von einer Momentanfrequenz auf $f_L$
- HOLD : Anhalten während des internen Sweepablaufs bei jeder beliebigen Momentanfrequenz
- Blanking (ohne Bedienungselement): Unterdrückung des Ausgangssignals während des Sweep-Rücklaufs

**Interner Frequenzablauf**

Sweep-Charakteristik: Logarithmisch




T = Sweepperiode
$T_R$ = Rücklaufzeit
$f_L$ = untere Frequenzgrenze des Sweepbereichs
$f_H$ = obere Frequenzgrenze des Sweepbereichs

Sweep-Eckfrequenzverhältnis $f_H/f_L$ (SWEEP RATIO): 1 ... $10^4$, stetig einstellbar
In der **Sweep-Vorbereitungsstellung SET $f_L$** (untere Frequenzgrenze)

Sweep-Periode (SWEEP PERIOD): 1 ... 100 s, stetig einstellbar

Rücklaufzeit: 80 ... 200 ms

**LOG ($f/f_H$)-Ausgang**: BNC-Buchse

Ausgangsspannung: −4 V ... 0 V, 1 V/Frequenzdekade; mit wachsender Frequenz, also bei Annäherung von f an $f_H$ gegen 0 gehend

Innenwiderstand: 1 k Ω

Maximaler Strom: 4 mA

**PEN LIFT - Ausgang** (Geräterückwand): BNC-Buchse

angepasst an die X-Y-Schreiber PHILIPS PM 8041, PM 8125, PM 8132 und PM 8141

| | | |
|---|---|---|
| max. Strom | 0,5 A | **elektronischer Schalter** |
| Ausgangsspannung | < 0,7 V | geschlossen |
| Ausgangsspannung | +15 V | elektronischer Schalter |
| Innenwiderstand | 15 kΩ | geöffnet |

**Externe Frequenzsteuerung**

| | |
|---|---|
| **SWEEP IN - Steuereingang** | BNC-Buchse |
| Sweep-Eckfrequenzverhältnis $f_H/f_L$ | 1 ... $10^4$, abhängig von der Steuerspannung an der Buchse SWEEP IN |
| Eingangsimpedanz | 10 k Ω //1 nF |
| Empfindlichkeit | 1 Frequenzdekade/V, Frequenz steigt bei positiv gehender Spannung |
| max. zulässige Eingangsspannung | ± 20 V |
| maximale Sweep-Frequenz | ca. 400 Hz, mit zeitsymmetrischer dreieckförmiger Steuer-Spannung |
| maximale Modulationsfrequenz für FM (kleiner Frequenzhub) | 2 kHz |
| **OUTPUT - Signalsausgang** | BNC-Buchse |
| Innenwiderstand | 50 Ω |
| Signalformen | zeitsymmetrischen Sinus, Dreieck oder Rechteck |
| Leerlaufspannung | 0,07 V ... 6 V (Spitze-Spitze), stetig einstellbar |
| Belastbarkeit | kurzschlussfest |
| *Sinusspannung* | |
| Frequenzabhängigkeit (Referenzwert 1 kHz) | < 1 %, bis 100 kHz<br>< 3 %, bis 1 MHz |
| Klirrfaktor | < 0,5 %, typisch 0,2 %; unter 100 kHz bei FREQ MULTIPL in Stellung x0,01 und x1<br>< 2,0 %, typisch 0,4 %, bis 1 MHz bei FREQ MULTIPL in Stellung x10 |
| *Rechteckspannung* | |
| Anstiegs- und Abstiegszeit | < 60 ns, typisch 50 ns |
| Überschwingen und Welligkeit | < 2 % |
| Gleichspannungsoffset | < 50 mV, bei maximaler Signalspannung |

EINFLUSSGRÖSSEN

Die angegebenen Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND, angefordert werden.

| | |
|---|---|
| **Umgebungstemperatur** | |
| Referenzwert | 23 °C ± 1 °C |
| Nenngebrauchsbereich | +5 °C ... +40 °C |
| Grenzbereich für Lagerung und Transport | –40 °C ... +70 °C |
| **Relative Luftfeuchte** | |
| Referenzbereich | 45 % ... 75 % |
| Nenngebrauchsbereich | 20 % ... 80 % |
| **Luftdruck** | |
| Referenzwert | 1013 mbar (≙760 mmHg) |
| Nenngebrauchsbereich | 800 mbar ... 1066 mbar (bis 2200 m Höhe) |
| **Geschwindigkeit der umgebenden Luft** | |
| Referenzbereich | 0 m/s ... 0,2 m/s |
| Nenngebrauchsbereich | 0 m/s ... 0,5 m/s |

| | |
|---|---|
| **Betriebslage** | beliebig |
| **Versorgungsspannung** | Netzwechselspannung |
| Referenzwert | 230 V |
| Nennwerte | 115 V/230 V |
| Nennbetriebsbereich | ± 15 % vom eingestellten Nennwert |
| Frequenznennbereich | 50 Hz ... 100 Hz |
| – Toleranz | ± 5 % |
| Leistungsaufnahme | 27 W |
| **Anwärmzeit** | 30 Minuten |

GEHÄUSE

| | |
|---|---|
| Schutzart nach DIN 40050 | IP 20 |
| Schutzklasse nach IEC | Klasse I, Schutzleiter |
| Abmessungen (über alles) | |
| – Höhe | 145 mm |
| – Breite | 240 mm |
| – Tiefe | 200 mm |
| Gewicht | ca. 3,5 kg |

## 1.3. ZUBEHÖR

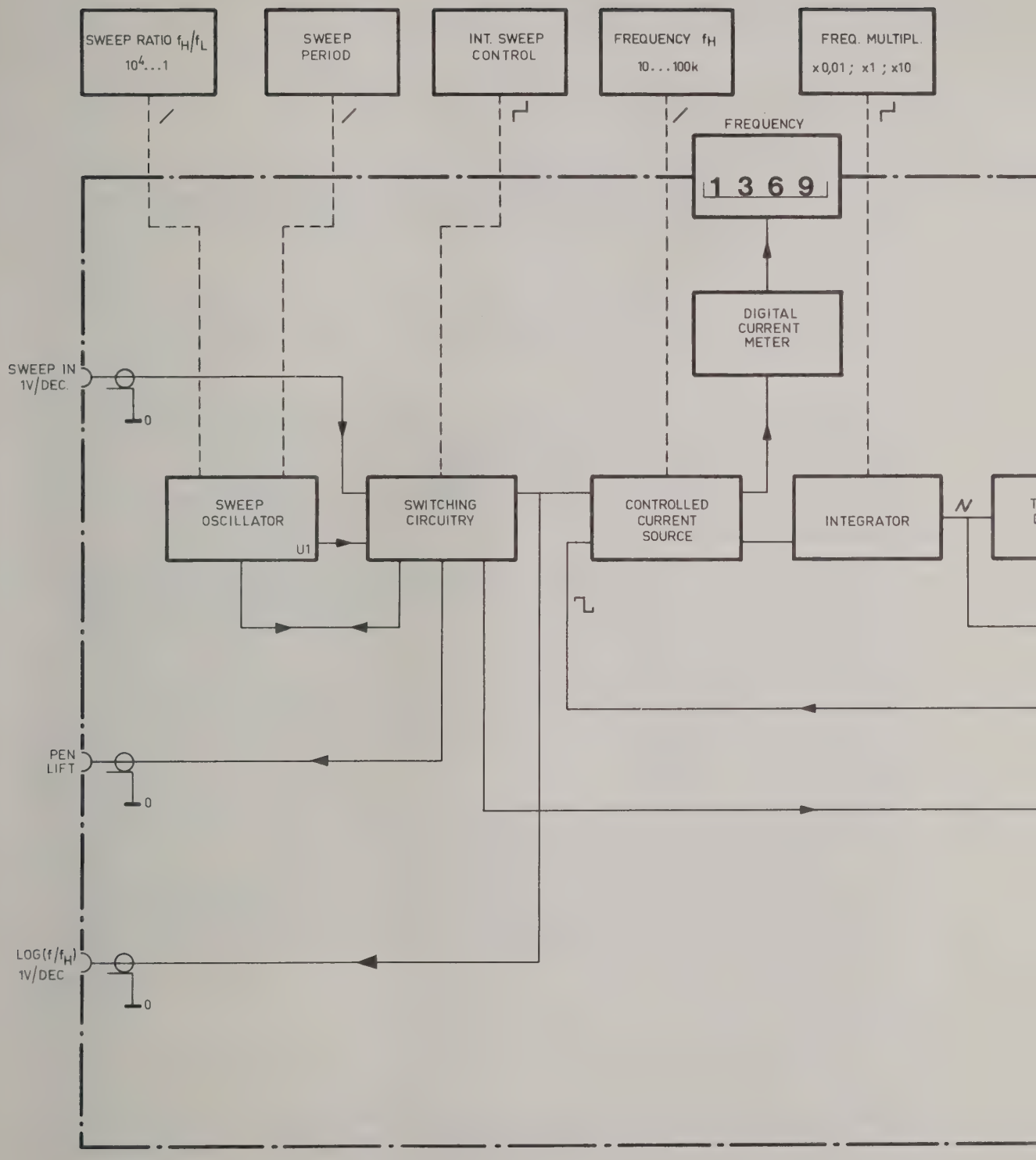
| | |
|---|---|
| Normalzubehör | Gerätehandbuch |
| Sonderzubehör | PM 9585, 50-Ω-Abschluss 1 W<br>PM 9075, Koaxialkabel BNC-BNC |

## 1.4. FUNKTIONSBESCHREIBUNG (Fig. 1)

Der Hauptoszillator des Generators enthält die Funktionsblöcke CONTROLLED CURRENT SOURCE, INTEGRATOR und TWO LEVEL DETECTOR in einer geschlossenen Schleife.
Die CONTROLLED CURRENT SOURCE stellt einen Spannungs/Strom-Konverter dar, der den Ladestrom für den INTEGRATOR erzeugt. Die Stromrichtung kann vom TWO LEVEL DETECTOR her umgesteuert werden. Auf diese Weise entstehen am Ausgang des INTEGRATOR eine zeitsymmetrische Dreieckspannung und am Ausgang des TWO LEVEL DETECTOR eine zeitsymmetrische Rechteckspannung.
Die Frequenz des Oszillators wird durch die der CONTROLLED CURRENT SOURCE zugeführte Steuerspannung, die Frequenzeinsteller FREQUENCY $f_H$ Hz und die Bereichstasten FREQ MULTIPL bestimmt und durch die Leuchtdiodenanzeige FREQUENCY angezeigt. Das DIGITAL CURRENT METER enthält die hierfür erforderliche Messschaltung.
Die Steuerspannung wird entweder vom interen SWEEP OSCILLATOR erzeugt oder vom Steuereingang SWEEP IN her zugeführt. Die Umschaltung erfolgt mit den Tasten INT SWEEP CONTROL im SWITCHING CIRCUITRY.
Der Sweepbereich für die interne Sweepsteuerung durch den SWEEP OSCILLATOR kann durch die Steller SWEEP RATIO $f_H/f_L$ festgelegt werden. Die Sweepperiode ist mit dem Steller SWEEP PERIOD einstellbar.

Mit dem Signalformschalter WAVEFORM kann wahlweise das Dreieck oder Rechtecksignal des Hauptoszillators über BLANKING SWITCH, ATTENUATOR und OUTPUT AMPLIFIER dem Signalausgang OUTPUT zugeführt werden. In Stellung ~ des Schalters WAVEFORM wird in den Dreiecksignalweg der Sinusformer SINE SHAPER eingefügt.
Der BLANKING SWITCH unterbricht während der Sweep-Rücklaufphase den Signalweg. Die Ansteuerung erfolgt vom SWITCHING CIRCUITRY.
Mit dem Steller AMPLITUDE ist die Amplitude des Ausgangssignals stetig einstellbar.
Der PEN-LIFT -Ausgang ist mit einem elektronischen Schalter innerhalb der SWITCHING CIRCUITRY verbunden, der während der Sweep-Rücklaufphase geöffnet wird.
Die jeweils der CONTROLLED CURRENT SOURCE zugeführte Steuerspannung steht gleichzeitig am AUSGANG LOG ($f/f_H$) zur Verfügung.

Im entstörten Netzteil werden die im Gerät benötigten stabilisierten Versorgungsspannungen erzeugt.


SWEEP RATIO $f_H/f_L$
$10^4 \ldots 1$
SWEEP PERIOD
INT. SWEEP CONTROL
FREQUENCY $f_H$
10 . . . 100k
FREQ. MULTIPL.
x0,01 ; x1 ; x10
FREQUENCY
1 3 6 9
DIGITAL CURRENT METER
SWEEP IN 1V/DEC.
0
SWEEP OSCILLATOR
U1
SWITCHING CIRCUITRY
CONTROLLED CURRENT SOURCE
INTEGRATOR
PEN LIFT
0
LOG(f/$f_H$) 1V/DEC
0

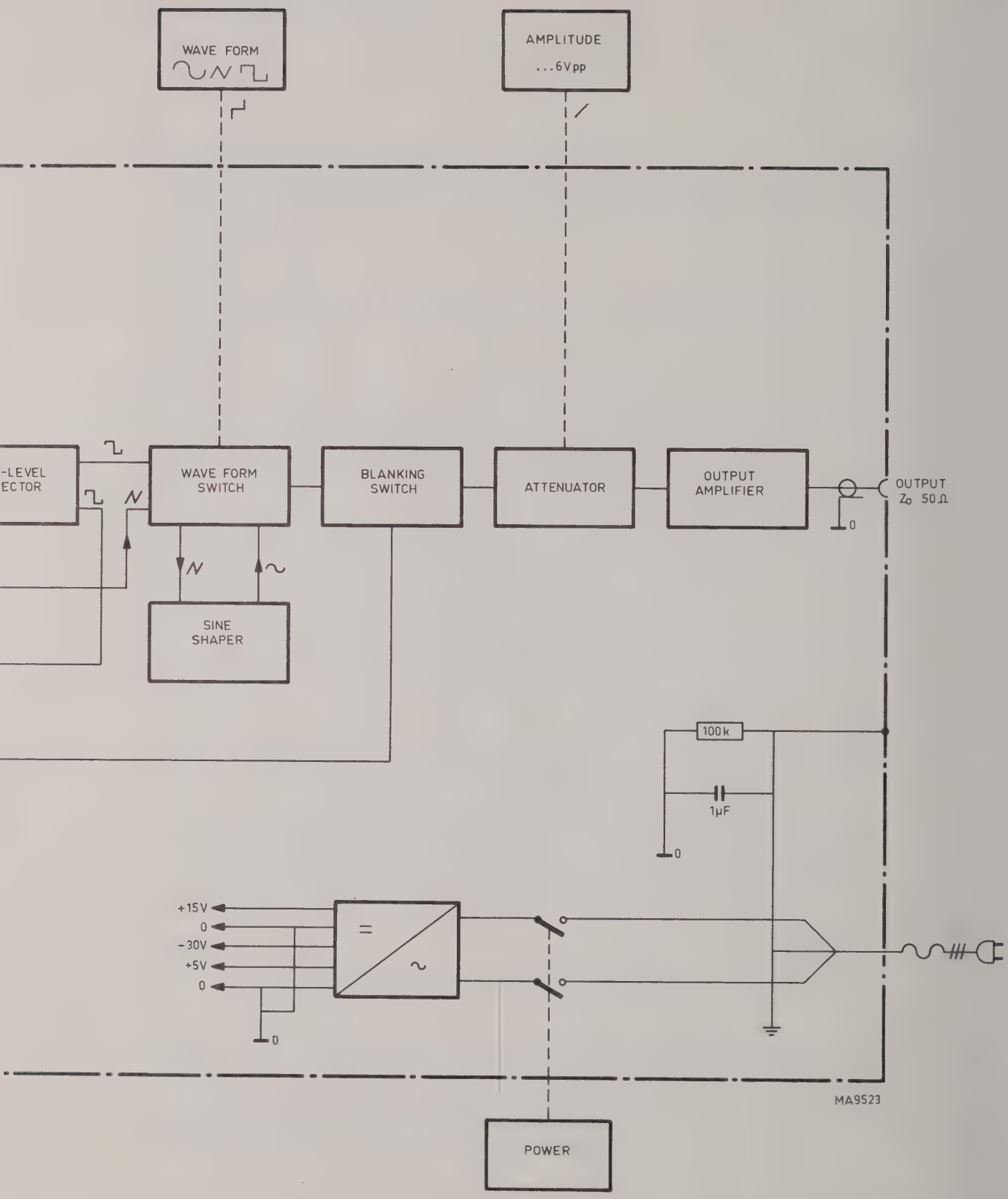



Abb. 1. Blockschaltbild PM 5165

# 2. Vorbereitungsanweisungen

## 2.1. WICHTIGE SICHERHEITSTECHNISCHE HINWEISE

Dieses Gerät hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Zur Erhaltung dieses Zustands und seines gefahrlosen Betriebs empfehlen wir, die nachfolgenden Hinweise sorgfältig zu beachten.

### 2.1.1. Vor dem Anschliessen

*Netzspannung*

Es ist sicherzustellen, dass die eingestellte Betriebsspannung des Geräts und die Nenn-Netzspannung übereinstimmen.

*Schutzklasse*

Dieses Gerät ist ein Gerät der Schutzklasse I (Schutzleiteranschluss) gemäss IEC 348 oder VDE 0411. Die mitgelieferte Netzzuleitung enthält einen Schutzleiter. Ausser in besonders zugelassenen Räumen darf der Netzstecker nur in Schutzkontaktsteckdosen eingeführt werden.
Jede Unterbrechung des Schutzleiters, innerhalb oder ausserhalb des Geräts, ist unzulässig.

### 2.1.2. Reparatur und Wartung

*Fehler und aussergewöhnliche Beanspruchungen*

Wenn anzunehmen ist, dass ein gefahrloser Betrieb nicht mehr möglich ist, so ist das Gerät ausser Betrieb zu setzen und gegen unabsichtlichen Betrieb zu sichern.
Dieser Fall tritt ein,
- wenn das Gerät sichtbare Beschädigungen aufweist,
- wenn das Gerät nicht mehr arbeitet,
- nach Überbeanspruchungen jeglicher Art (z.B. Lagerung, Transport), die die zulässigen Grenzen überschreiten.

*Öffnen des Geräts*

Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein.

Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundenen Gefahren kennt.

Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde, die Schaltbilder sind zu beachten.

*Sicherungen*

Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden.

*Reparatur, Ersatz von Teilen*

Reparaturen sind fachgerecht durchzuführen. Dabei ist besonders darauf zu achten, dass die konstruktiven Merkmale des Geräts nicht sicherheitsmindernd verändert werden. Insbesondere dürfen die Kriech- und Luftstrecken und die Abstände durch die Isolierung hindurch nicht verkleinert werden.

Zum Ersatz nur Original-Teile verwenden. Andere Ersatzteile sind nur zulässig, wenn dadurch die sicherheitstechnischen Eigenschaften des Geräts nicht verschlechtert werden.

## 2.2. AUFSTELLEN

Das Gerät darf in beliebiger Lage aufgestellt und betrieben werden. Mit Hilfe des heruntergeklappten Tragbügels kann das Gerät in nach hinten gekippter Lage aufgestellt werden.

Die Belüftungsöffnungen an Boden und Deckel dürfen nicht verdeckt werden. Es ist ferner darauf zu achten, dass das Gerät nicht auf andere Wärmequellen gestellt oder übermässiger Wärmeeinstrahlung ausgesetzt wird.

## 2.3. ERDEN

Das Gerät muss den örtlichen Vorschriften entsprechend geerdet werden. Die mit dem Gerät fest verbundene Netzzuleitung enthält einen Schutzleiter und ist mit Schutzkontaktsteckern versehen. Hierdurch wird beim Anschluss an eine Schutzkontaktsteckdose das Gehäuse des Geräts zwangsläufig mit Schutzerde verbunden.

**ACHTUNG:** Der Netzanschlussstecker darf nur in eine Schutzkontaktsteckdose eingeführt werden. Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch eine unvollkommene Verlängerungsleitung !

Die Aussenkontakte der BNC-Buchsen führen das Schaltungsnullpunkt-Potential und sind mit dem Gehäuse über die Parallelschaltung eines Kondensators und eines Widerstands verbunden. Damit wird eine eindeutige HF-Erdung der Schaltung bewirkt.
Eine Schutzerdung über die Aussenkontakte der BNC-Buchsen ist unzulässig !

## 2.4. NETZSPANNUNGSKONTROLLE UND ANPASSUNG; NETZANSCHLUSS

Dieses Gerät darf nur an Wechselspannung betrieben werden.
Es ist bei Auslieferung auf einen Netzspannungsbereich von 230 V ± 15 % eingestellt.

Vor dem Anschliessen an das Netz ist zu prüfen, ob der Netzspannungstransformator auf die örtliche Netzspannung (± 15 %) eingestellt ist. Die eingestellte Spannung kann auf dem Netzspannungsschild an der Gehäuserückwand abgelesen werden.

Soll das Gerät auf einen anderen Netzspannungsbereich umgestellt werden, ist wie folgt zu verfahren:

- Netzstecker herausziehen.
- Gehäusedeckel abnehmen, dazu zwei Schrauben an der Rückseite entfernen
- Drahtbrücken an den vier Lötstützpunkten auf der Printplatte UNIT 3 entsprechend dem Anschlussschema umlöten (siehe Fig. 2).
- Netzspannungsschild an der Gehäuserückwand entsprechend der eigestelleten Netzspannung montieren.
- Gerät schliessen.

Das Gerät ist den örtlichen Sicherheitsvorschriften entsprechend an das Netz anzuschliessen. Dazu ist das Gerät über die Netzzuleitung mit einer Schutzkontaktsteckdose zu verbinden (siehe auch 2.3.).

Abb. 2. Anschlussschaltbild für die verschiedenen Netzspannungen

# 3. Betriebsanleitung

## 3.1. BEDIENUNGSELEMENTE UND ANSCHLÜSSE (Abb. 3 und Abb. 4)

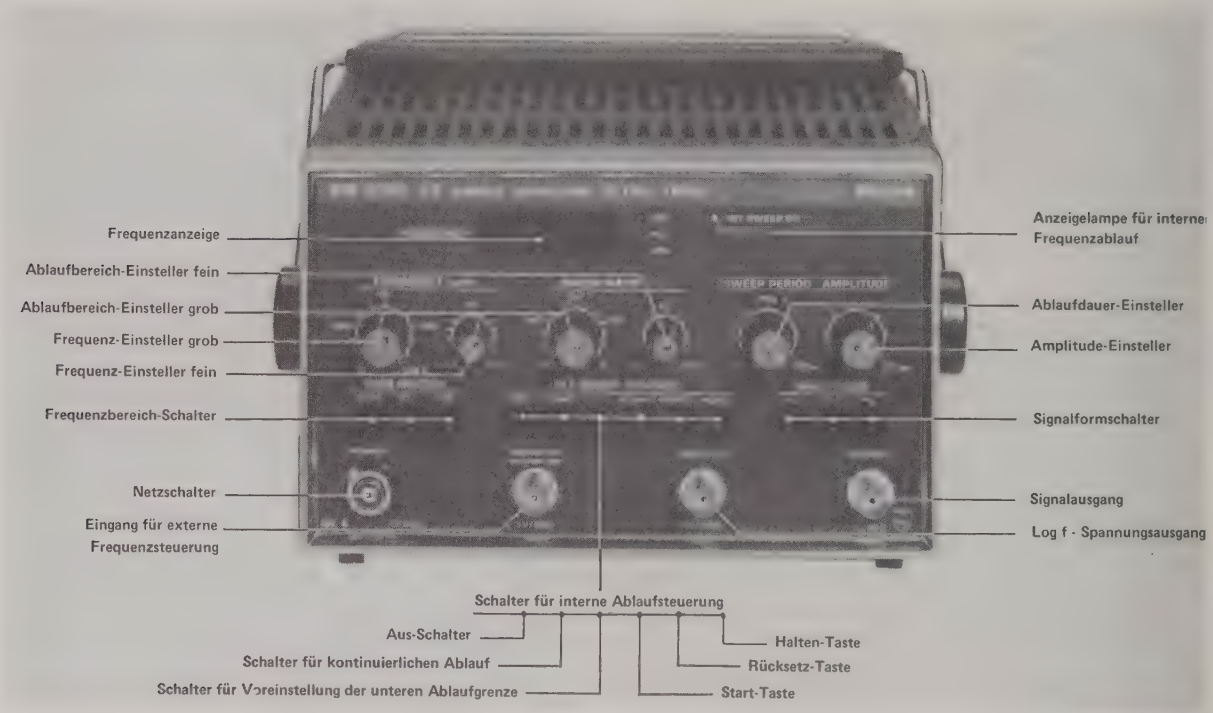



Abb. 3. Frontansicht

Abb. 4. Rückansicht

## 3.2. BEDIENUNG

### 3.2.1. Einschalten des Geräts

Nachdem die Verbindung des Geräts mit dem Netz gemäss 2.3. und 2.4 hergestellt ist, wird es durch Drücken der Netzschaltertaste POWER eingeschaltet.
Das weiße Feld im Knopf des Netzschalters gibt mechanisch an, dass das Gerät eingeschaltet ist.
Nach einer Anwärmzeit von 30 Minuten bei unveränderter Lage hält es seine im Kap. 1.2. "Technische Daten" angegebenen Kenngrössen ein.

### 3.2.2. Einstellen der Signalform und -amplitude

Die gewünschte Ausgangssignalform wird durch Drücken der entsprechenden Taste (~ ' ∿ ' ⊓) des Signalformschalters WAVEFORM eingestellt.
Die Signalamplitude an der BNC-Buchse OUTPUT ist mit dem Steller AMPLITUDE auf Leerlaufwerte zwischen 0,07 V und 6 V (Spitze-Spitze) stetig einstellbar.

### 3.2.3. Einstellen der oberen Frequenzgrenze $f_H$

Die Frequenz $f_H$ ist in der Betriebsart INT SWEEP COTROL OFF einzustellen. Dafür muss die entsprechende Taste OFF gedrückt werden.
Zum Einstellen der oberen Frequenzgrenze $f_H$ stehen drei Bedienungselemente zur Verfügung:

1. Frequenzeinsteller grob FREQUENCY $f_H$ Hz mit logarithmischer Skala
2. Frequenzbereichschalter FREQ MULTIPL
3. Frequenzeinsteller fein FREQUENCY $f_H$ Hz (x0.9 bis 1.1)

Die mit den oben angegebenen Bedienungselementen eingestellte Frequenz des Ausgangssignals ist gleich dem Produkt aus den Zahlenwertangaben der beiden Frequenzeinsteller-Skalen und dem Zahlenwert der gedrückten Taste des Frequenzbereichschalters.
(Beispiel: Frequenzeinsteller grob auf 1 k, fein auf x1 und Frequenzbereichschalter x10 gedrückt ergibt eine Ausgangsfrequenz von 10.000 Hz = 10 kHz).
Diese Frequenz wird ausserdem von der Leuchtdiodenanzeige FREQUENCY genau angezeigt.
In der vorausgesetzen Betriebsart INT SWEEP CONTROL OFF, ist $f_H$ die momentane Signalfrequenz am Generatorausgang OUTPUT.
Bei interner Sweepsteuerung ist $f_H$ die obere Frequenzgrenze des Sweepbereichs.
Bei externer Sweepsteuerung ist $f_H$ die resultierende Frequenz bei einer Eingangssteuerspannung von 0 V.

### 3.2.4. Einstellen der unteren Frequenzgrenze $f_L$

Nachdem sichergestellt ist, dass die angezeigte Frequenz $f_H$ richtig eingestellt ist (Abschnitt 3.2.3.) ist die Taste SET $f_L$ des Schalters INT SWEEP CONTROL zu drücken.
Das Sweepverhältnis $f_H/f_L$ und somit die gewünschte untere Frequenzgrenze $f_L$ des Sweepbereichs wird mit den Stellern SWEEP RATIO $f_H/f_L$ eingestellt, wobei $f_L$ von der Leuchtdiodenanzeige FREQUENCY genau angezeigt wird.
Zum einstellen der unteren Frequenzgrenze stehen zwei Bedienungselemente zu Verfügung:

1. Steller SWEEP RATIO $f_H/f_L$ grob, mit logarithmischer Skala
2. Steller SWEEP RATIO $f_H/f_L$ fein (x1.1 bis x0.9)

Die Einstellung mit diesen Potentiometern ist relativ, deshalb ist das Einstellen von $f_L$ immer abhängig von der Einstellung der oberen Frequenzgrenze $f_H$.
(Beispiel: Die obere Frequenzgrenze $f_H$ wurde auf 100 kHz und das Sweepverhältnis wurde auf $10^2$ eingestellt, die resultierende untere Frequenzgrenze $f_L$ beträgt dann 1 kHz).
$f_L$ ist die untere Frequenzgrenze des Sweepbereichs bei interner Sweepsteuerung, sowohl für periodischen Ablauf (CONT) als auch für die Auslösung einzelner Perioden (START).
Nach dem Auslösen des Sweepablaufs durch Drücken der Taste CONT oder START (siehe Abschnitt 3.2.5) beginnt der Sweep mit der Frequenz $f_L$, die Frequenz steigt dann exponentiell bis zur Frequenz $f_H$.

### 3.2.5. Interne Sweepsteuerung

Nachdem die Frequenzgrenzen des Sweepbereichs eingestellt sind (Abschnitte 3.2.2., 3.2.3. und 3.2.4.), ist der Generator sowohl für die Auslösung einzelner Sweepperioden als auch für einen periodischen Sweepablauf vorbereitet.

Einzelne Sweepperioden werden durch Drücken der Taste START des Schalters INT SWEEP CONTROL ausgelöst. Die Frequenz des Ausgangssignals durchläuft eine Sweepperiode, sie beginnt mit der unteren Frequenzgrenze $f_L$, steigt exponentiell bis zur oberen Frequenzgrenze $f_H$ und läuft dann schnell zur unteren Frequenzgrenze $f_L$ zurück. Sie wird von einer Schaltlogik solange auf diesen Wert festgehalten, bis die Taste START erneut gedrückt wird.
Die Dauer der Sweepperiode ist von der Einstellung des Stellers SWEEP PERIOD abhängig.
Während des schnellen Rücklaufs der Frequenz wird das Ausgangssignal unterdrückt. Zusätzlich öffnet der elektronische Schalter des PEN LIFT-Ausgangs.
Ein sich periodisch wiederholender Sweepablauf wird durch Drücken der Taste CONT des Schalters INT SWEEP CONTROL eingestellt. Die Frequenz des Ausgangssignal läuft periodisch von $f_L$ exponentiell zu $f_H$ und schnell zurück zu $f_L$. Die Dauer einer Sweepperiode wird mit dem Steller SWEEP PERIOD eingestellt.

Durch Drücken der Taste RESET des Schalters INT SWEEP CONTROL wird die Frequenz des Ausgangssignals bei jedem beliebigen Augenblickswert während des Sweepablaufs auf die untere Frequenzgrenze $f_L$ zurückgesetzt.
Mit der Taste HOLD des Schalters INT SWEEP CONTROL kann der Sweepablauf bei jeder beliebigen Momentanfrequenz angehalten werden.
Diese Frequenz wird festgehalten, solange die Taste HOLD gedrückt wird.

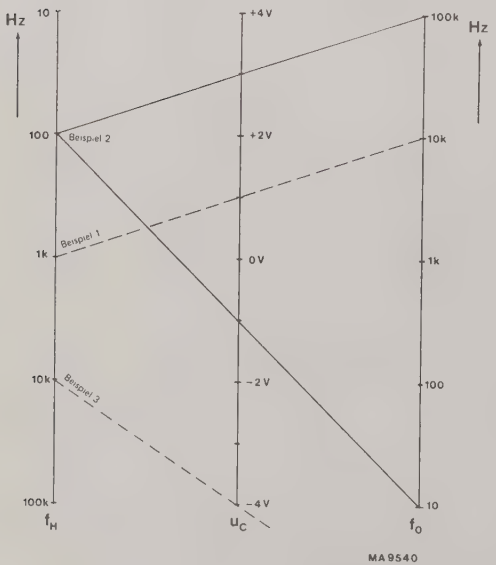
### 3.2.6. Externe Sweepsteuerung

In der Betriebsart INT SWEEP CONTROL OFF kann durch Einspeisen eines Signals in die BNC-Buchse SWEEP IN die Frequenz des Generators gesteuert werden. Dafür muss die entsprechende Taste OFF gedrückt werden.
Die Frequenz des Generators ändert sich dabei exponentiell mit der Steuerspannung (1 V/Dekade) nach der Funktion:

$$f_O = f_H \cdot 10^{\frac{U_C}{V}}$$

Darin ist: $f_O$ = Momentane Signalfrequenz am Generatorausgang OUTPUT
$f_H$ = Voreingestellte Frequenz bei einer Eingangssteuerspannung von = 0 V, angezeigt von der Leuchtdiodenanzeige
$U_C$ = Steuerspannung am Eingang SWEEP IN

Die Frequenz $f_O$ wird von der Leuchtdiodenanzeige angezeigt.

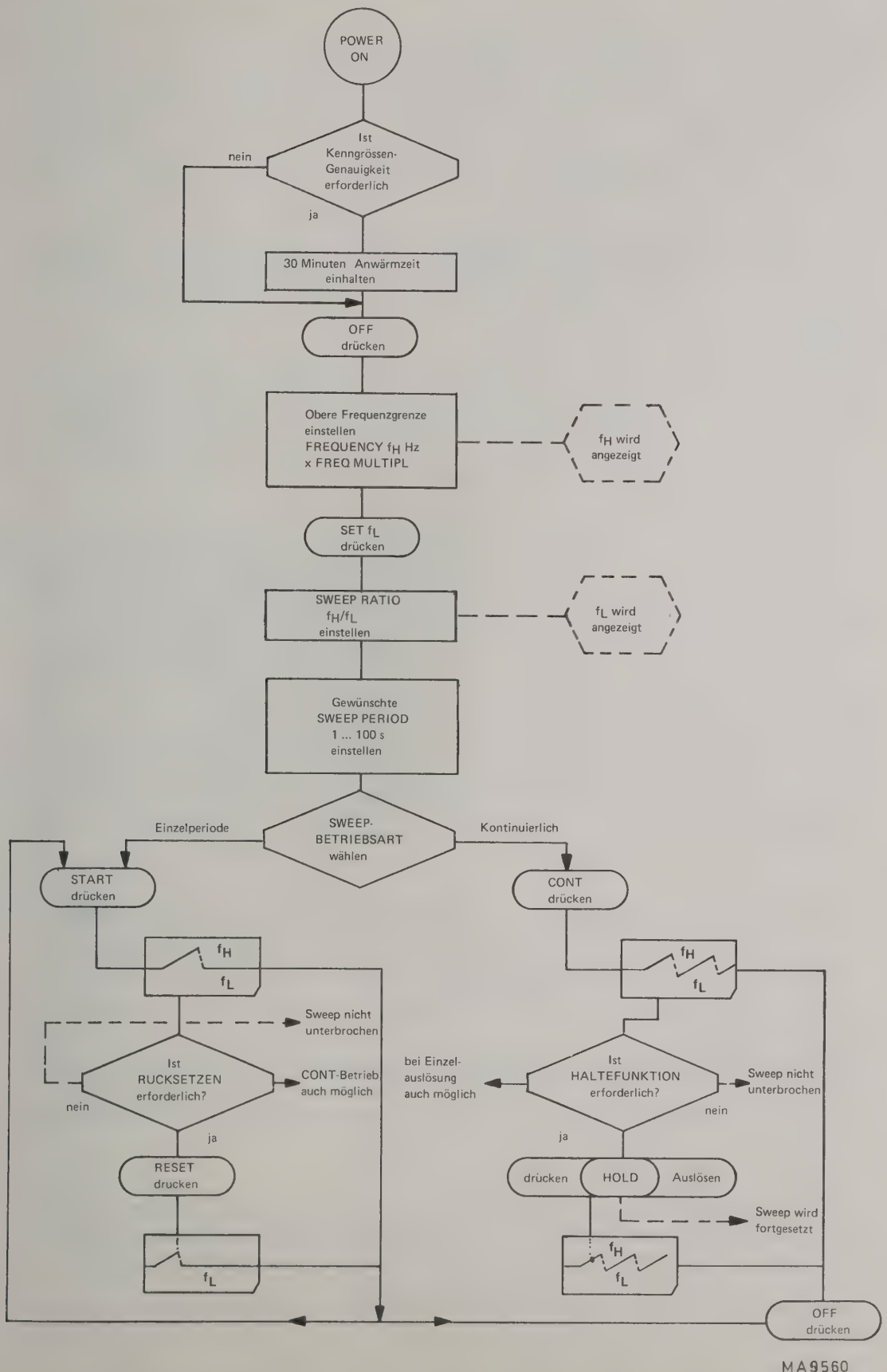



| | | |
|---|---|---|
| Beispiel 1: | $f_H$ eingestellt auf | 1 k . Faktor B |
| | Steuerspannung $U_C$ | +1 V |
| | Ausgangsfrequenz $f_O$ | (1 k . Faktor B . $10^{+1}$) Hz |
| Beispiel 2: | $f_H$ eingestellt auf | 100 . Faktor B |
| | Steuerspannung $U_C$ | Dreieckspg. $U_{SS}$ = 4 V, mit einer Gleichspannung von +1 V überlagert |
| | Ausgangsfrequenz $f_O$ | stufenlos zwischen den Hubgrenzen (100 . Faktor B . $10^{-1}$) Hz und (100 . Faktor B . $10^{+3}$) Hz |
| Beispiel 3: | $f_H$ eingestellt auf | 10 k . Faktor B |
| | Steuerspannung $U_C$ | −4 V |
| | Ausgangsfrequenz $f_O$ | nicht definiert |

Abb. 5. Sweepbereich PM 5165

Den angegebenen Wert für $f_H$ mit dem Wert der gedrückten Taste des Bereichsschalters FREQ MULTIPL ( = Faktor B) multiplizieren !

### 3.2.7. Flussdiagram der internen Frequenzsteuerung



## 3.3. ANWENDUNG

Kennlinienaufnahme im HiFi-Bereich

Bei hochwertigen NF-Geräten und –Übertragungsanlagen sind konventionelle Messmethoden, wie zum Beispiel punktweises Aufnehmen von Kennlinien mit Generator und Indikator nicht mehr zweckentsprechend. Man bevorzugt dynamische Methoden wie das Prüfen mit Rechtecksignalen. Obgleich der Aufwand an Messmittel und Zeit verhältnismässig gering ist, lässt die Genauigkeit der Aussage zu wünschen übrig. Allerdings sind bei Stereoverstärkern die Übertragungseigenschaften beider Kanäle miteinander leicht vergleichbar und Amplitude und Phasenfehler schnell zu analysieren.

### 3.3.1. Messanordnung

Für genauere Messergebnisse und deren Dokumentation stehen seit kurzer Zeit zwei aufeinander abgestimmte NF-Messgeräte zur Verfügung, mit denen man in Verbindung mit einem X-Y-Schreiber genauere Kennlinien aufzeichnen kann.

#### *3.3.1.1. Massstäbe der Kennlinien*

Wegen der grossen relativen Bandbreite des Übertragungsbereichs und der Grösse der Amplitudenvariation ist es zweckmässig, in beiden Richtungen logarithmische Massstäbe zu verwenden. Beide Geräte, der Sweep-Generator PHILIPS PM 5165 und der Verstärker PM 5171 haben logarithmische Ausgänge und sind für einen schnellen Messaufbau geeignet.

#### *3.3.1.2. Blockschaltbild der Messanordnung*

Der Sweep-Generator PM 5165 liefert ein Sinussignal mit konstanter Amplitude, dessen Frequenz im Bereich von 13 Hz bis 100 kHz logarithmisch variiert ist, Bild 6. Diese Frequenz wird am Eingang R dem Stereoverstärker eingespeist. Der Eingang L ist mit einer R-C-Kombination 47 kOhm//220 pF abgeschlossen, mit einer Impedanz die etwa dem Innenwiderstand der steuerenden Quellen bei normaler Anwendung entspricht. Die Ausgänge des Prüflings sind mit je einem 4,7-Ohm-Widerstand belastet.
Über den LOG $f/f_H$-Ausgang des Sweep-Generators wird der X-Eingang des X-Y-Schreibers (PM 8041) gesteuert. Somit ist die Amplitude des Schreibstifts in der X-Richtung logarithmisch mit der Frequenz des Sinussignals verknüpft.

Der Verstärker PM 5171 wird von dem Spannungsabfall am Lastwiderstand des Prüflings gesteuert. Er hat drei Ausgänge LOG CONV out, AC to DC CONV (Linear-Ausgang) und AMPL out. Der Ausgang LOG CONV out ist mit dem Eingang X des X-Y-Schreibers verbunden, an den Ausgang AC to DC CONV out von PM 5171 kann für Kontrollzwecke ein Oszillograf angeschlossen werden. Bei kleinen Amplitudenänderungen kann, der Y-Eingang des X-Y-Schreibers mit dem Ausgang AC to DC CONV OUT von PM 5171 verbunden werden. So ist die Ablenkcharakteristik des Schreibstifts in Y-Richtung linear.

### 3.3.2. Amplitudengang

Amplitudengänge in Abhängigkeit von der Frequenz zeigt Bild 7. Hier erkennt man besonders die Bedeutung der logarithmischen Massstäbe in Y- und X-Richtung. Die Mittenfrequenz des Übertragungsbereichs liegt etwa in der Mitte des Diagramms, ebenso der mittlere Amplitudenwert. Als Parameter dienen die Extremstellungen und die Mittelstellung der Klangreglerorgane.

Aufschlussreich ist, dass bei diesem Prüfling die Amplitude der Mittenfrequenz durch die Klangregler kaum beeinflusst werden kann.

Die messtechnische Auswertung dieses Diagramms ist durch einige Messdaten angedeutet, die für sich selbst sprechen.

Der Amplitudengang des anderen Kanals wird sinngemäß aufgezeichnet und ggf. mit dem des ersten Kanals verglichen.

#### *3.3.2.1. Gehörrichtige Lautstärkeregelung*

Die Wirksamkeit der gehörrichtigen Lautstärkeregelung zeigt Bild 8. Anstelle der Klangkorrektur dient hier die Ausgangsleistung als Parameter. Der Messaufbau entspricht der Darstellung in Bild 6. Mann erkennt, dass bei kleineren Lautstärken die mittleren Frequenzen gegenüber den Tiefen und Höhen abgesenkt sind. Das entspricht dem Empfindlichkeitsverlauf des menschlichen Gehörs.
Bei der Aufnahme dieser Kurven standen die Regler für die Klangkorrektur in Mittelstellung.

*3.3.2.2. Gleichlauf der Amplitudengänge*

Den Amplitudengang je Kanal zeigt Bild 9, bei geringfügig verstellter Balance und erhöhter Empfindlichkeit in Y-Richtung so wie bei Klangkorrektur in Mittelstellung. Die untere Kurve gilt für den Kanal L bei Gleichstellung der Pegel bei 50 Hz.

*3.3.2.3. Übersprechen*

Das Übersprechen des Signals von einem Kanal auf den anderen zeigt Bild 10. Der Kanal R ist bis zu einer Ausgangsleistung von 6,7 Watt ausgesteuert bei Klangkorrektur in Mittelstellung.
Die Empfindlichkeit in Y-Richtung ist reduziert. Der Eingang des Kanals L ist mit einer Impedanz von 47 kOhm//220 pF überbrückt, in übrigen gilt der Messaufbau gemäss Bild 6.
Die Übersprechdämpfung vom L-Kanal zeigt die dritte Kurve von oben bei der gezeichneten Aussteuerung des Kanals R. Die zweite und vierte Kurve für eine Ausgangsleistung von 0,1 Watt.
Die Übersprechdämpfung ist, wie man erkennt, frequenzabhängig. Sie schwankt im Übertragungsbereich der Grundwellen, der etwa von 50 Hz bis 15 kHz reicht, von etwa 30 bis 50 dB. Ab 10 kHz nimmt das Übersprechen stark zu, was aber belanglos ist, da die Amplituden der in diesem Bereich liegenden Frequenzen bei Musikübertragung verhältnismässig klein sind.
Das Übersprechen ist bei der Mittenfrequenz am geringsten, es kommt bei tiefen Frequenzen hauptsächlich durch den endlichen Widerstand einer gemeinsamen Stromversorgung zustande.
Die Zunahme des Übersprechens mit steigender Frequenz wird durch Streukapazitäten der heissen Potentiale und Verkopplung über Streuinduktivitäten der Masseverbindungen verursacht.

Der richtige Anschluss des PEN LIFT Ausgangs des PM 5165 an PHILIPS X-Y-Schreiber ist nachstehender Tabelle zu entnehmen

| *PM 5165 (Rückwand)* | *BNC-Buchse Mittlerer Anschluss (+15 V)* | *BNC-Buchse Ausserer Anschluss (Signal Erde)* |
|---|---|---|
| PM 8041 (Boden) | Amphenol Stecker Anschluss 2 | Amphenol Stecker Anschluss 1 |
| PM 8125 | BU101 Anschluss 2 | BU101 Anschluss 1 |
| PM 8132 | 24-poliger Stecker Anschluss 11 | 24-poliger Stecker Anschluss 21 oder 22 |
| PM 8141 | Amphenol Stecker Anschluss 2 | Amphenol Stecker Anschluss 1 |

Für Anschluss des PEN LIFT Ausgangs an andere X-Y-Schreiber, ist das Service Handbuch der betreffenden Hersteller zu Rate zu ziehen.

# 1. Généralités

# Notice d'emploi

## 1.1. INTRODUCTION

Le générateur wobbulé basse fréquence PM 5165 délivre des signaux de sortie sinusoidaux, triangulaires ou rectangulaires de 0,1 Hz à 1 MHz. Ces signaux peuvent être balayés sur quatre décades par un oscillateur wobbulé incorporé ou par un signal externe.
Les boutons-poussoirs pour fréquence wobbulée interne permettent de sélectionner en mode simple ou continu et de maintenir le signal en tout point de la wobbulation, par exemple lorsqu'il s'agit d'examiner plus en détails le phénomène à cette fréquence, de plus, le signal de commande est remis à la fréquence de démarrage.
Un affichage LED à 4 chiffres indique la fréquence de sortie. L'indication de la gamme de fréquence et la wobbulation interne sont également indiquées à l'aide de LED.
La période de wobbulation est réglable de 1 sec à 100 sec.
Des boutons-poussoirs permettent de sélectionner la forme du signal de sortie, sinusoidale, triangulaire et rectangulaire.
Le signal de sortie est continuellement variable jusqu'a 6 $V_{CC}$ et disponible à la douille BNC à l'avant, à une impédance de 50 Ω.
Une tension de fréquence analogue de l'oscillateur wobbulé de 1 V/décade est disponible à la douille de sortie lorsque l'appareil est combiné avec des appareils marginaux tels que les enregistreurs.
Une sortie PEN LIFT (levage du style) pour commande d'enregistreur X-Y est disponible à l'arrière du générateur.

## 1.2. CARACTERISTIQUES TECHNIQUES

A la livraison, cet appareil répond aux consignes de sécurité pour les appareils de mesure et de contrôle. Les instructions et avertissements contenus dans ce mode d'emploi doivent être observés par l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

- Seules les valeurs indiquées avec une tolérance ou une limite sont garanties; les caractéristiques sans tolérance sont données à tirtre indicatif.
- Toutes les spécifications sont valables après un temps de chauffe de 30 min. en tenant l'appareil dans une position de montage constante.
- Les précisions (absolues ou en %) se rapportent à la valeur de référence indiquée.

SPECIFICATIONS

**Fréquence**

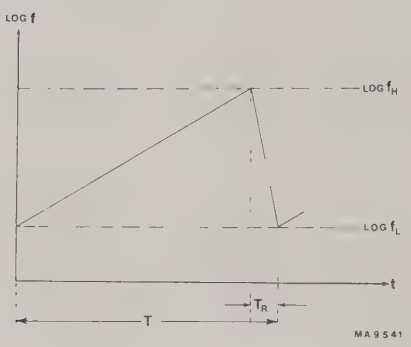
| | |
|---|---|
| Gamme nominale | 0,1 Hz à 1 MHz |
| Gammes sélectionnées | 0,1 Hz à 1 kHz<br>10 Hz à 100 kHz<br>100 Hz à 1 MHz |
| Réglage | – trois boutons-poussoirs de gamme: FREQ MULTIPL x0,01 , x1 , x10<br>– approximatif, commande FREQUENCY $f_H$ Hz avec échelle logarithmique de 10 à 100 k<br>– fin, commande FREQUENCY $f_H$ Hz avec échelle linéaire x0,9 à x1,1 |
| Affichage | Digital LED (3½ chiffres) avec changement automatique de gamme (points décimaux et lampes de gamme) |
| Précision d'affichage | ± 1 % ± 1 chiffre aux conditions de référence de traveil |
| Coefficient de température de l'affichage | < 0,1 %/°C |

**Fonction de commande wobbulée**

| | |
|---|---|
| – OFF | Préréglé pour fréquence supérieure $f_H$ de la gamme de balayage.<br>$f_H$ est indiqué par l'affichage FREQUENCY.<br>Le balayage de fréquence externe est possible. |
| – HOLD | Arrêt à la fréquence instantanée pendant le balayage interne |
| – START | Déclenchement d'une période de balayage simple |
| – CONTINUOUS | Répétition périodique interne des cycles de balayage |
| – RESET | Remise de la fréquence instantanée pendant le balayage interne sur $f_L$ |
| – SET $f_L$ | Préréglé pour fréquence inférieure $f_L$ de la gamme de balayage |
| – BLANKING | Suppression du signal de sortie pendant le retour de balayage. |

**Fréquence wobbulée interne**

Caractéristique — Logarithmique




T = Période de balayage
$T_R$ = Période de retour
$f_L$ = fréquence inférieure de la gamme de balayage
$f_H$ = fréquence supérieure de la gamme de balayage

| | |
|---|---|
| Rapport wobbulé $f_H/f_L$ | 1 à $10^4$, continuellement variable en SET $f_L$ |
| Période de balayage | 1 à 100 s, continuellement variable |
| Période de retour | 80 ... 200 ms |
| **Sortie LOG ($f/f_H$)** | Douille BNC |
| Tension de sortie | –4 V ... 0 V, 1 V/décade de fréquence; positive avec fréquence croissante.<br>Proche de 0 à $f_H$ |
| Résistance interne | 1 k Ω |
| Courant maximal | 4 mA |
| **Sortie levage du style** | Douille BNC |
| (arrière de l'appareil) | |
| Adapté aux enregistreurs X-Y: PHILIPS PM 8041, PM 8125, PM 8132 et PM 8141 | Courant maximal 0,5 A<br>Tension de sortie < 0,7 V } (commutateur électronique fermé)<br>Tension de sortie +15 V<br>Résistance interne 15 kΩ } (commutateur électronique ouvert) |

| | |
|---|---|
| **Entrée SWEEP IN** | Douille BNC |
| Rapport de wobbulation $f_H/f_L$ | 1 à $10^4$, en fonction de la tension de commande à l'entrée SWEEP IN |
| Impédance d'entrée | 10 kΩ//1 nF |
| Sensibilité | 1 fréquence décade/V; avec tension de commande positive, la fréquence croît |
| Tension maximale d'entrée | ± 20 V |
| Fréquence maximale de wobbulation | 400 Hz environ avec signal triangulaire symétrique en temps |
| Fréquence de modulation maximale pour FM (légères variations) | 2 kHz |
| **Signal OUTPUT (de sortie)** | Douille BNC |
| Impédance interne | 50 Ω |
| Signaux | symétrique en temps sinusoïdal, triangulaire ou rectangulaire |
| Tension de sortie en circuit ouvert | 0,07 $V_{CC}$ à 6 $V_{CC}$, continuellement variable |
| Charge | exempte de courts-circuits |
| *Onde sinusoïdale* | |
| Réponse en amplitude (valeur de référence 1 kHZ) | < 1 % jusqu'à 100 kHz<br>< 3 % jusqu'à 1 MHz |
| Distorsion de sinusoïde | < 0,5 % jusqu'à 100 kHz; typique 0,2 % avec FREQ MULTIPL en positions x0,01 et x1<br>< 2 % jusqu'à 1 MHz; typique 0,4 % avec FREQ MULTIPL en position x10 |
| *Onde rectangulaire* | |
| Temps de montée et de descente | < 60 ns; typique 50 ns |
| Dépassement et suroscillation | < 2 % |
| Offset continue | < 50 mV à amplitude maximale |

## CONDITIONS D'ENVIRONNEMENT

Les données d'environnement ne sont valables que si l'appareil est contrôlé conformément aux normes officielles. Des détails à ce sujet et sur les critères de défaillance sont disponibles sur demande à l'Organisation PHILIPS de votre pays, ou à N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLANDE

| | |
|---|---|
| **Température ambiante** | |
| Valeur de référence | 23 °C ± 1 °C |
| Gamme nominale | +5 à +40 °C |
| Gamme de stockage et de transport | −40 à +70 °C |
| **Humidité relative** | |
| Gamme de référence | 45 à 75 % |
| Gamme nominale de travail | 20 à 80 % |
| **Pression d'air** | |
| Valeur de référence | 1013 mbar (≙ 760 mm Hg) |
| Gamme nominale de travail | jusqu'à 2200 m d'altitude (800 à 1066 mbar) |
| **Déplacement d'air** | |
| Valeur de référence | 0 à 0,2 m/s |
| Gamme nominale de travail | 0 à 0,5 m/s |

| | |
|---|---|
| **Position de travail** | au choix |
| **Alimentation** | secteur alternative |
| Valeur de référence | 230 V |
| Valeurs nominales | 115/230 V |
| Gamme nominale de travail | ± 15 % de la valeur nominale sélectionnée |
| Gamme de fréquence | 50 à 100 Hz |
| – tolérance | ± 5 % |
| Consommation | 27 W |
| Période de chauffage | 30 min. |
| COFFRET | |
| Classe de protection (voir CEI 348) | Classe I, conducteur de terre |
| Type de protection (voir CEI 144) | IP 20 (voir DIN 40 050) |
| Dimensions totales | |
| – hauteur | 145 mm |
| – largeur | 240 mm |
| – profondeur | 300 mm |
| Poids | env. 3,5 kg |

## 1.3. ACCESSOIRES

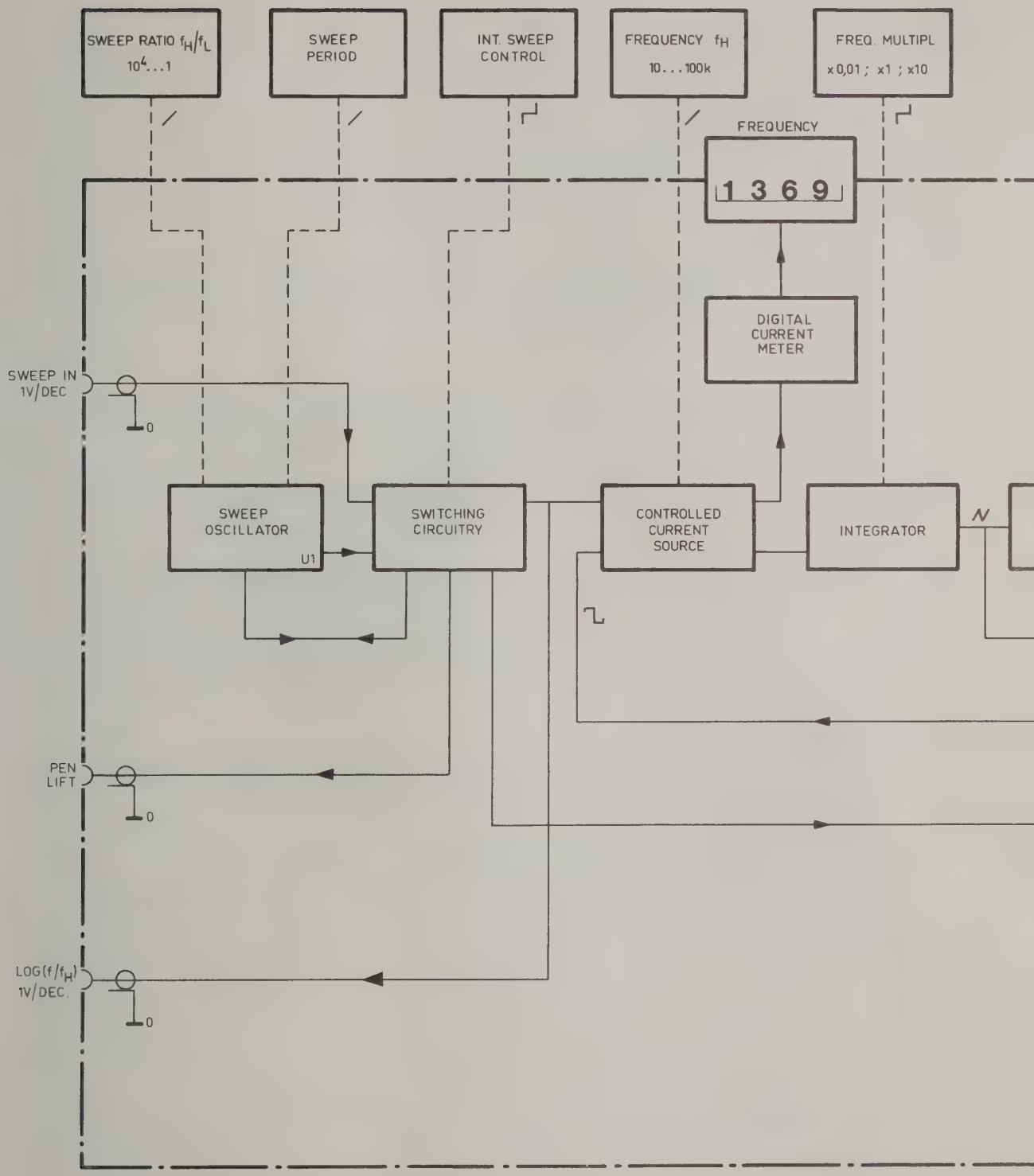
| | |
|---|---|
| Accessoires fournis avec l'appareil | notice d'emploi et d'entretien |
| Accessoires en option | PM 9585 : résistance terminale 50 Ω 1 W<br>PM 9075 : câble de connexion BNC-BNC |

## 1.4. DESCRIPTION DU SCHEMA SYNOPTIQUE (fig. 1.)

L'oscillateur principal du générateur est composé d'une source de courant réglée, d'un intégrateur et d'un détecteur à deux niveaux ou d'un comparateur en circuit fermé. La source de courant réglée sert de convertisseur tension/courant, qui fournit le courant de charge pour l'intégrateur.
La polarité de ce courant de charge est réglée par le détecteur à deux niveaux. Des ondes symétriques en temps apparaissent, l'une triangulaire à la sortie d'intégrateur et l'autre rectangulaire à la sortie du détecteur à deux niveaux.
La fréquence de l'oscillateur est déterminée par la tension de commande à l'entrée de la source de courant réglée, la commande de fréquence $f_H$ Hz et les commutateurs de gamme FREQ MULTIPL. La fréquence est indiquée par l'affichage LED FREQUENCY (fréquence).
Aussi l'affichage digital de courant est-il muni du circuit de mesure nécessaire.
La tension de commande est fournie soit par l'oscillateur de balayage interne, soit par l'entrée de commande externe SWEEP IN. Les commutateurs INT SWEEP CONTROL permettent, par l'intermédiaire du circuit de commutation, tantôt la wobbulation interne, tantôt la wobbulation externe.
La tension de commande appliquée à la source de courant réglée est disponible à la sortie LOG $f/f_H$.
Pour déterminer la gamme de balayage interne par l'oscillateur de balayage, on fait appel à la commande SWEEP RATIO $f_H/f_L$. La période de balayage est variable à l'aide de la commande SWEEP PERIOD.

Le signal triangulaire ou rectangulaire de l'oscillateur principal, sélectionné à l'aide du commutateur WAVEFORM est appliqué à la sortie de signal par l'intermédiaire du commutateur de suppression (blanking), de l'atténuateur et de l'amplificateur de sortie. En position commutateur WAVEFORM, l'onde triangulaire est appliqué conformateur d'ondes sinusoïdales et à la douille de sortie par la ligne de signal. Le commutateur de suppression interrompt cette ligne pendant le retour de balayage; la commande se fait par le circuit de commutation.
La commande AMPLITUDE permet de faire varier continuellement l'amplitude du signal de sortie.
La sortie de levage du style est connectée à un commutateur électronique dans le circuit de commutation, lequel est ouvert pendant le retour du balayage.

L'alimentation exempte d'interférences produit des tensions continues stabilisées pour les différents circuits.


SWEEP RATIO $f_H/f_L$
$10^4$...1
SWEEP PERIOD
INT. SWEEP CONTROL
FREQUENCY $f_H$
10...100k
FREQ. MULTIPL
x0,01 ; x1 ; x10
FREQUENCY
1369
DIGITAL CURRENT METER
SWEEP IN 1V/DEC
0
SWEEP OSCILLATOR
U1
SWITCHING CIRCUITRY
CONTROLLED CURRENT SOURCE
INTEGRATOR
N
PEN LIFT
0
LOG(f/$f_H$) 1V/DEC.
0

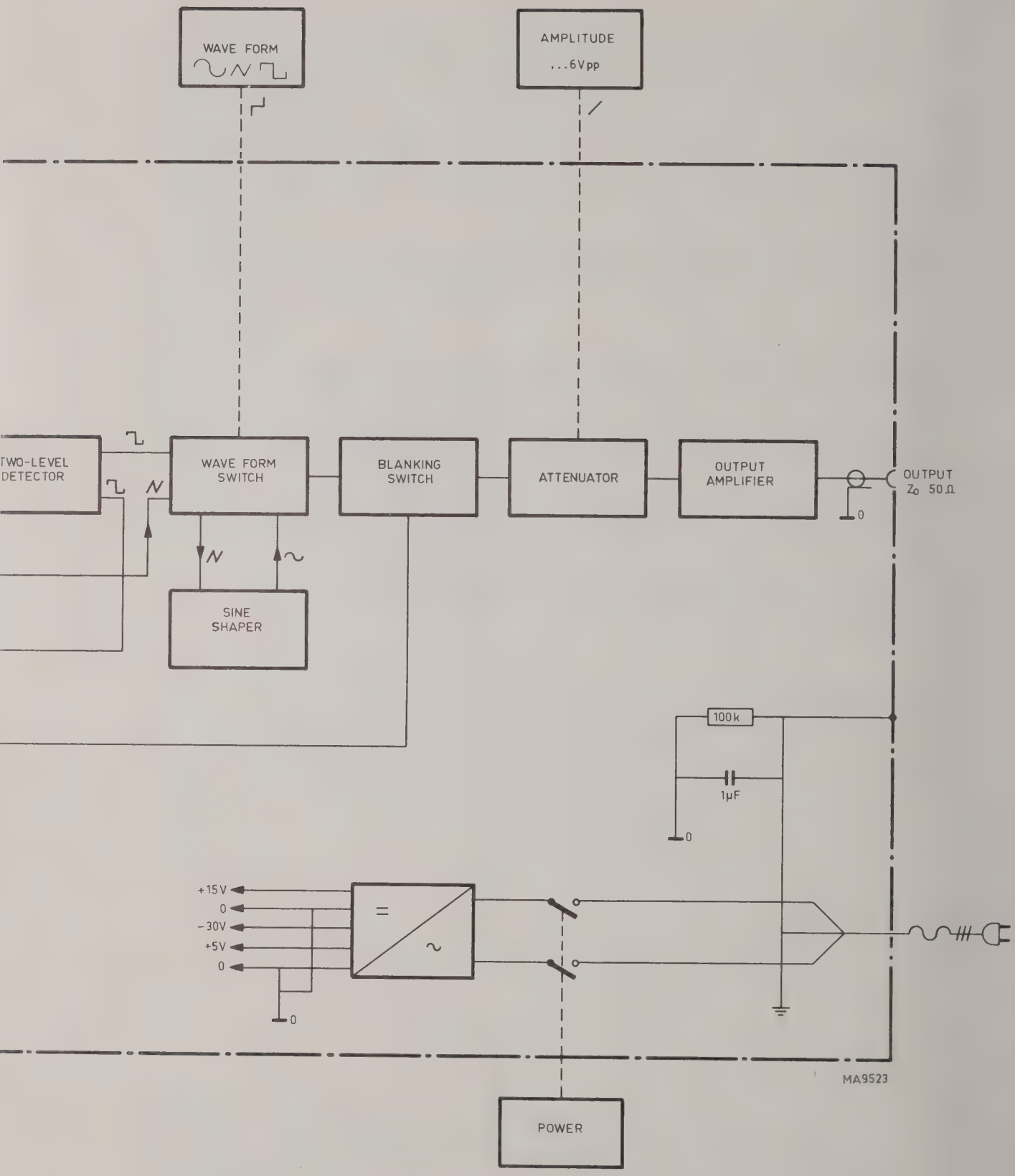



Fig. 1. Schéma synoptique de PM 5165

# 2. Installation

## 2.1. REGLES DE SECURITE (voir CIE 348 ou VDE 0411)

Avant de brancher l'appareil au secteur, vérifier si le coffret, les commandes et les connecteurs etc. ont subi quelque dommage en cours de transport. Au cas où des défauts apparents sont observés, ne pas connecter l'appareil au secteur.
Toujours débrancher l'appareil avant de l'ouvrir. Les travaux de maintenance et d'entretien à effectuer avec l'appareil enclenché doivent l'être par un technicien qualifié.
La fiche secteur ne peut être branchée que sur une prise avec terre. Ne jamais éliminer cette protection, par exemple à l'aide d'un câble prolongateur sans conducteur de terre.

## 2.2. POSITIONNEMENT

L'appareil peut être utilisé horizontalement ou en position inclinée à l'aide de l'étrier-support. S'assurer que les trous de ventilation dans les tôles supérieure et de fond ne soient pas obstrués. Ne pas mettre l'appareil sur une surface chaude ni l'exposer directement au soleil.

## 2.3. MISE A LA TERRE

L'appareil doit être mis à la terre conformément aux régles de sécurité locales. Le cordon secteur livré avec l'appareil est pourvu d'un conducteur de terre, s'adaptant dans les contacts de terre de la prise.
Avant toute mise sous tension, l'appareil doit être connecté à la terre de l'une des manières suivantes:
- Par la borne de terre de l'appareil
- Par le cordon secteur à trois conducteurs. La fiche secteur ne doit être introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'une câble prolongateur sans conducteur de terre.

**ATTENTION:** Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.
Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

## 2.4. BRANCHEMENT AU SECTEUR

Avant de brancher la fiche secteur, s'assurer que l'appareil est réglé sur la tension secteur locale. L'appareil ne peut être branché que sur une alimentation en alternatif. A la livraison, l'appareil est réglé sur 230 V ± 15%.
Au cas où l'appareil doit être alimenté par 115 V ± 15 %, procéder comme suit:
- Débrancher l'appareil
- Desserrer les deux vis à l'arrière et déposer la tôle inférieure.
- Modifier les connexions primaires du transformateut conformément à l'indication sur l'unité 3 et à la figure 2.
- Changer la plaquette de tension secteur à l'arrière conformément à la sélection.
- Fermer l'appareil

Fig. 2. Schéma de branchement pour differentes tensions d'alimentation

*Remplacement des fusibles*

Avant de brancher la fiche secteur, s'assurer que l'appareil est réglé sur la tension locale.
S'assurer que des fusibles correctement calibrés et du modèle convenable sont utilisés en cas de remplacement.
Il faut éviter d'utiliser des fusibles réparés. En cas de remplacement d'un fusible l'appareil doit être débranché de toutes sources de tension.
Adaptation au secteur et remplacement de fusibles ne peuvent se faire que par une personne qualifiée, consciente du risque encouru.

# 3. Manipulations

## 3.1. COMMANDES ET DOUILLES (fig. 3 et 4)

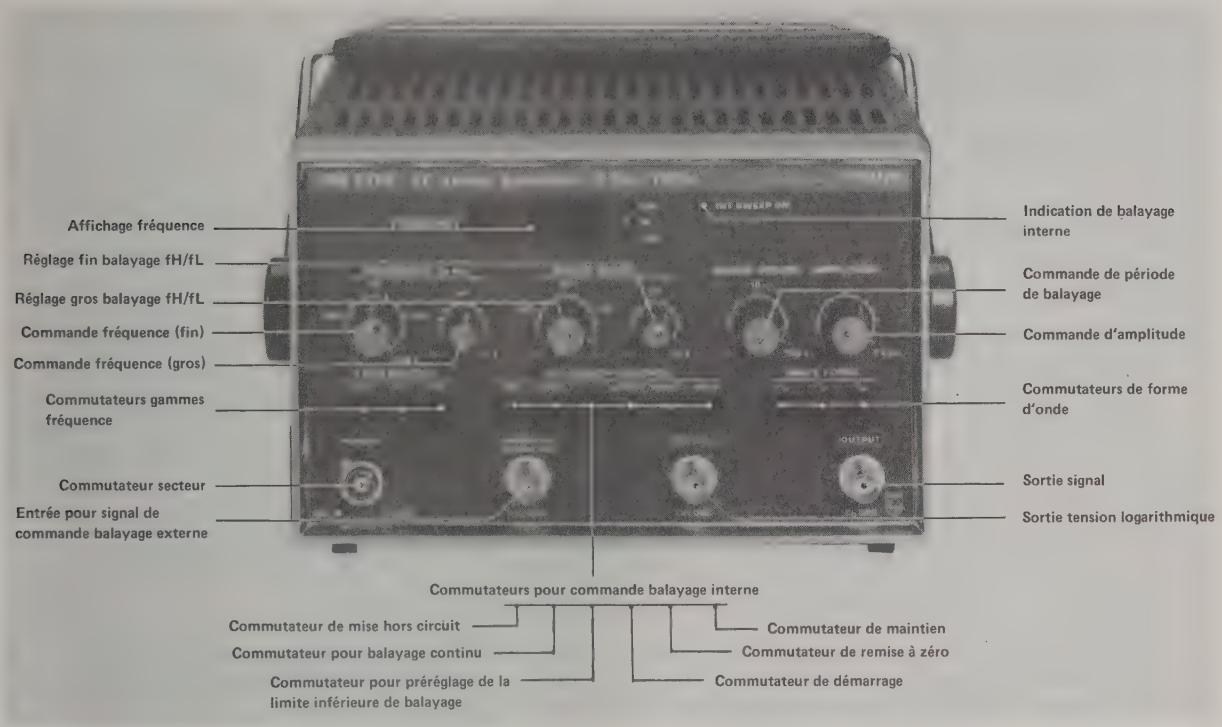



Fig. 3. Panneau avant, commandes et douilles

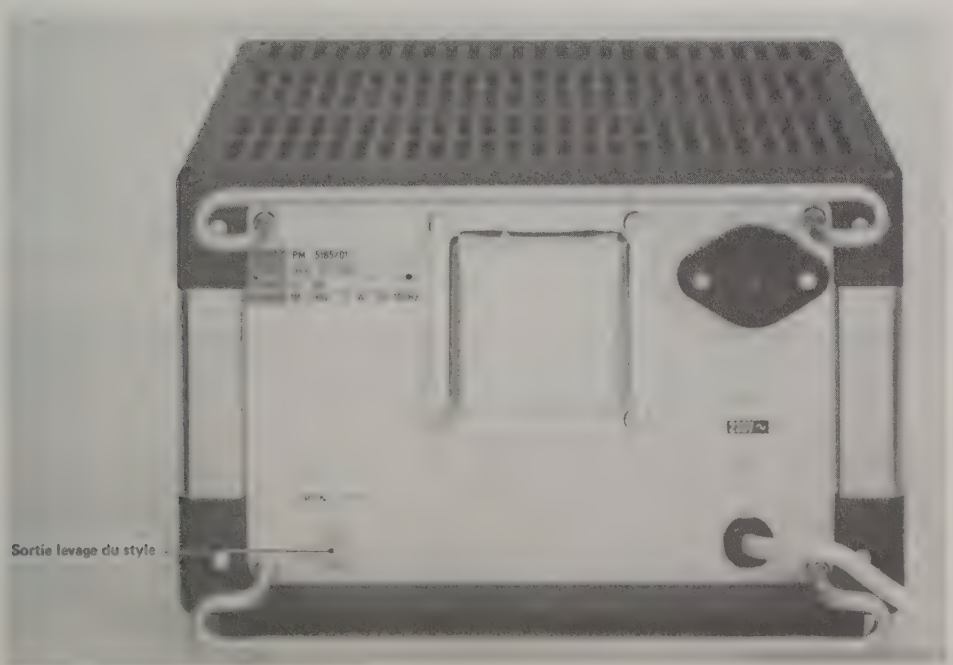



Fig. 4. Panneau arrière, commandes et douilles

## 3.2. FONCTIONNEMENT

### 3.2.1. Enclenchement

Après avoir branché le générateur wobbulé au secteur conformément aux sections 2.1.3. et 2.1.4., on l'enclenche en enfonçant le bouton POWER.
Le point blanc dans le bouton est une indication mécanique de l'enclenchement.
L'appareil est prêt à l'usage après une période de chauffage de 30 minutes en position constante.

### 3.2.2. Sélection d'onde et d'amplitude

Le signal de sortie peut être sélectionné à l'aide du sélecteur WAVEFORM ( ~ , ∿ ou ⊓ ).
L'amplitude à la douille OUTPUT BNC est continuellement variable entre 0,07 et 6 $V_{cc}$ à l'aide de la commande AMPLITUDE.

### 3.2.3. Réglage de la limite de gamme wobbulé supérieure $f_H$

S'assurer que le bouton-poussoir INT SWEEP CONTROL "OFF" est enfoncé; dans ce cas, $f_H$ est la fréquence réelle du signal de sortie.
Pour balayage interne, $f_H$ constitue la limite supérieure de la gamme. Pour balayage externe, $f_H$ est la fréquence de sortie résultante pour tension d'entrée 0 V sur SWEEP IN.
Les trois commandes suivantes permettent de régler la limite de fréquence supérieure:

1. approximatif, commande FREQUENCY $f_H$ Hz à échelle logarithmique
2. boutons-poussoirs pour sélection de la gamme de fréquence FREQ MULTIPL: x0,01 , x1 , x10
3. fin, commande FREQUENCY $f_H$ Hz (x0,9 à x1,1)

Si la fréquence nominale requise est réglée à l'aide de ces commandes, la fréquence résultante = affichage d'échelle $f_H$ X facteur de multiplication du sélecteur de fréquence (exemple: affichage 1 k x1 et sélecteur de gamme x10 donnent une fréquence de sortie de 10 kHz).
De plus, cette fréquence est indiquée précisément par l'affichage FREQUENCY.

### 3.2.4. Réglage de la limite de gamme wobbulée inférieure $f_L$

S'assurer de l'affichage correct de $f_H$ (section 2.2.3). Ensuite, enfoncer le bouton-poussoir INT SWEEP CONTROL SET $f_L$ et régler les commandes de rapport wobbulé (SWEEP RATIO) afin d'afficher la limite de basse fréquence requise ($f_L$).
Pour réglage de la limite inférieure, on fait appel aux commandes suivantes:

1. commande de rapport wobbulé avec échelle logarithmique
2. commande d'offset wobbulé (x1,1 à x0,9)

Etant donné que ces commandes sont en rapport, le réglage de $f_L$ dépend du réglage de $f_H$. Par exemple, si le rapport wobbulé est réglé sur $10^2$ et $f_H$ sur 100 kHz, $f_L$ résultante est de 1 kHz.
$f_L$ correspond à la limite inférieure de fréquence pour balayage interne (continu ou simple).
Après avoir démarré le balayage à l'aide des boutons-poussoirs START ou CONT (section 3.2.5), le balayage démarré à $f_L$ et la fréquence augmente exponentiellement jusqu'à $f_H$.

Exemple: Si la limite supérieure ($f_H$) est de 20 kHz et qu'il faut wobbuler la bande de fréquence audio, un rapport wobbulé de trois décades est requis. Lorsque le rapport wobbulé est réglé sur $10^3$, une limite de basse fréquence de 20 Hz est affichée.

$$\frac{f_H}{f_L} = 10^3$$

ou

$$f_L = \frac{f_H}{10^3} = \frac{20.000}{10^3} = 20 \text{ Hz}$$

### 3.2.5. Mode de balayage interne

Après avoir réglé les limites de wobbulation (sections 3.2.2., 3.2.3., 3.2.4.), le générateur est prêt à l'usage soit en mode continu soit en mode monocourse.

Wobbulation monocourse: elle peut être démarrée en enfonçant le bouton-poussoir INT SWEEP CONTROL "START". La fréquence de la sortie donne une wobbulation simple de la limite inférieure $f_L$ à la limite supérieure $f_H$ à une période déterminée par la commande SWEEP PERIOD (période de wobbulation); celle-ci repasse ensuite à la limite inférieure $f_L$ pour y être maintenue par le circuit logique de commutation jusqu'à ce que le bouton START (démarrage) soit à nouveau enfoncé.
Pendant le retour de balayage, le signal de sortie est supprimé. De plus, le commutateur électronique de la sortie PEN LIFT (levage de style) est ouvert.

Wobbulation continue: elle peut être sélectionnée en enfonçant le bouton-poussoir INT SWEEP CONTROL "CONT". La fréquence de la sortie donne une wobbulation périodique de la limite inférieure $f_L$ à la limite supérieure $f_H$ ainsi qu'un retour de balayage. La période du cycle de balayage est déterminée par la commande SWEEP PERIOD.

Avec le bouton de commandes RESET (remise) la fréquence en tout point du balayage est remise à la limite inférieure. La commande HOLD peut être utilisée pendant la wobbulation pour maintenir toute fréquence instantanée sélectionnée afin de l'examiner avec bouton-poussoir enfoncé.

### 3.2.6. Mode de balayage externe

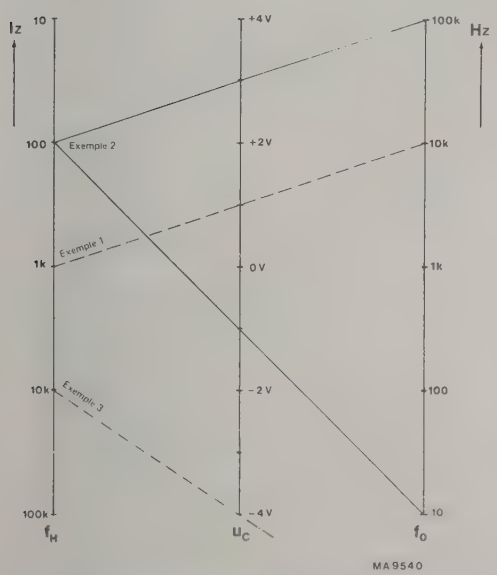
Le bouton-poussoir INT SWEEP CONTROL "OFF" doit être enfoncé. La fréquence du générateur peut être commandée en appliquant une tension externe à la douille coaxiale SWEEP IN. La fréquence du générateur change exponentiellement avec la tension de commande (1 V/décade) conformément à l'équation:

$$f_O = f_H \cdot 10^{\frac{U_C}{V}}$$

$f_O$ étant la fréquence instantanée du signal de la sortie de générateur

$f_H$ la valeur préréglée indiquée par l'affichage

$U_C$ la tension de commande à l'entrée SWEEP IN

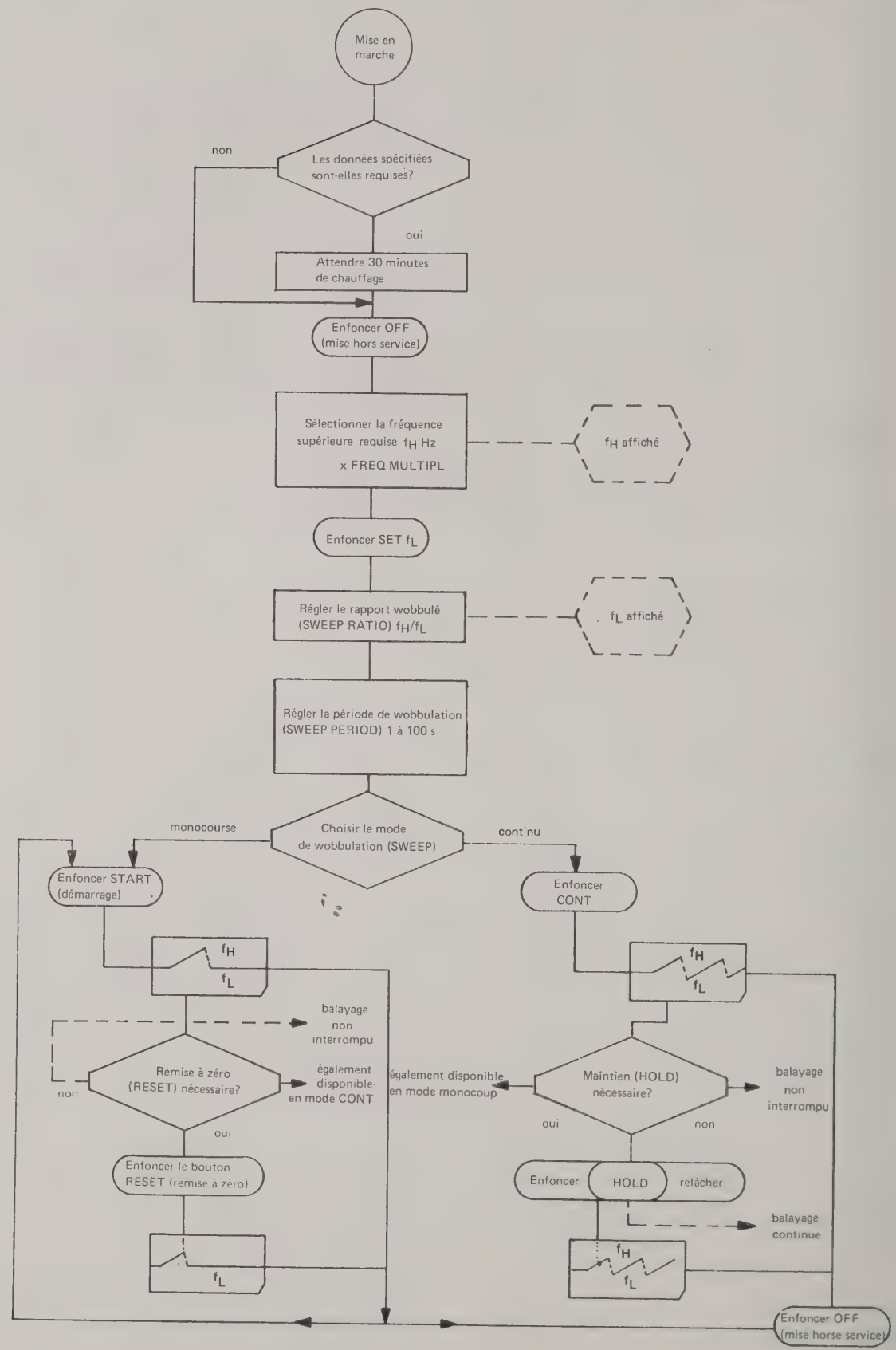



| | | |
|---|---|---|
| Exemple 1: | $f_H$ réglée sur | 1 k . facteur B |
| | tension de commande réglée sur | +1 V |
| | fréquence de sortie | (1 k . facteur B . $10^{+1}$) hz |
| Exemple 2: | $f_H$ réglée sur | 100 . facteur B |
| | tension de commande réglée sur | 4 $V_{cc}$ triangulaire, superposée à une tension continue de 1 V |
| | fréquence de sortie | continue entre les limites de balayage (100 . facteur B . $10^{-1}$) Hz et (100 . facteur B . $10^{+3}$) Hz |
| Exemple 3: | $f_H$ réglée sur | 10 k . facteur B |
| | tension de commande réglée sur | −4 V |
| | fréquence de sortie | indéfinie |

Fig. 5. Gamme de balayage de PM 5165

Multiplier la valeur $f_H$ par la valeur de la touche enfoncée du sélecteur FREQ MULTIPL (facteur B)

### 3.2.7. ORGANIGRAMME DU PROCESSUS DE WOBBULATION DE FREQUENCE INTERNE



## 3.3. APPLICATION

**Répresentation de la caractéristique dans la gamme haute fidélité**

Pour les appareils basse fréquence et systèmes de transmission de haute qualité, les méthodes de mesure conventionnelles, telles que la formation point par point d'une caractéristique à l'aide d'un générateur et d'un indicateur, ne remplissent plus leur but.
Aussi préfère-t-on les méthodes dynamiques telles que le contrôle avec des signaux sinusoïdaux. Quoique les frais d'équipement de mesure et le temps soient relativement réduits, la précision n'est pas optimale.
Cependant, pour des amplificateurs stéréo, les propriétés de transmission des deux voies sont faciles à comparer, car les erreurs d'amplitude et the phase peuvent être rapidement analysées.

### 3.3.1. Disposition de mesure

En vue de mesures plus précises, deux appareils de mesure basse fréquence complémentaires (Philips PM 5165 et PM 5171) sont disponibles; ces appareils combinés avec un enregistreur X-Y permettent d'enregistrer des caractéristiques plus précises.

#### *3.3.1.1. Choix de l'échelle de caractéristique*

Etant donné les importantes variations de largeur de bande et d'amplitude, l'échelle logarithmique dans les deux sens est récommandé. A cet effet, le générateur wobbulé PM 5165 et l'amplificateur PM 5171 sont pourvus de sorties logarithmiques et conviennent à la mesure rapide.

#### *3.3.1.2. Description du schéma synoptique* (fig. 6)

Le générateur wobbulé PM 5165 fournit un signal sinusoïdal d'amplitude constante, dont la fréquence est wobbulée logarithmiquement dans la gamme 13 Hz à 100 kHz. Cette fréquence est appliquée à l'entrée R de l'amplificateur stéréo. L'entrée L est terminée par un réseau RC 47 kΩ//220 pF, dont l'impédance correspond à l'impédance interne d'une source usuelle. Les sorties de l'appareil à tester sont chargées chacune par une résistance de 4,7 Ω.
Le générateur wobbulé commande l'entrée X de l'enregistreur X-Y (PM 8041) par l'intermédiaire de sa sortie LOG CONV OUT. De cette façon, l'amplitude du style en sens X est couplée logarithmiquement avec la fréquence du signal sinusoïdal.
La perte de tension à la résistance de charge de l'appareil testé sert à commander l'amplificateur PM 5171. Ce dernier est pourvu de trois sorties: LOG CONV OUT, AC to DC CONV OUT (sortie linéaire) et AMPLIFIER OUT. La sortie logarithmique est connectée à l'entrée X de l'enregistreur X-Y, tandis que la sortie amplificateur peut être connectée à un oscilloscope à des fins de contrôle. Pour des faibles changements d'amplitude, l'entrée Y de l'enregistreur X-Y peut être connectée à la sortie linéaire. La déflection Y du style est à choisir linéairement ou logarithmiquement.

### 3.3.2. Applications

Un amplificateur stéréo haute fidélité a été testé; pendant ce test on a couplé un enregistreur X-Y PM 8041 à l'ensemble de mesure.

#### *3.3.2.1. Réponse d'amplitude*

La figure 7 illustre les réponses d'amplitude en fonction de la fréquence. Les échelles logarithmiques en sens X et Y sont alors bien compréhensibles. La fréquence moyenne de la gamme de transmission se situe au milieu du diagramme, tout comme d'ailleurs la gamme moyenne d'amplitude. Les positions extrêmes et la position médiane des commandes de tonalité sont utilisés en tant que paramètres.
Dans ce cas, on observe que les commandes de tonalité influencent à peine l'amplitude de la fréquence moyenne. L'information supplémentaire sur le diagramme en facilite l'interprétation.
La réponse d'amplitude de l'autre voie est écrite de la même façon et être comparée éventuellement avec celle de la précédente.

#### *3.3.2.2. Réglage d'intensité sonore avec compensation du timbre*

La figure 8 illustre l'effet du réglage d'intensité sonore avec compensation du timbre. Dans ce cas, la sortie est utilisée comme paramètre au lieu de la correction d'intensité sonore.
La disposition de mesure correspond à celle de la figure 6.
On observe qu'à faible volume, les fréquences moyennes décroissent par rapport aux basses et hautes fréquences. Ceci correspond à l'audiogramme humain.

*3.3.2.3. Comparaison des réponses d'amplitude*

La figure 9 illustre la réponse d'amplitude par voie pour balance légèrement décalée, double sensibilité en sens Y et correction de tonalité en position médiane. La courbe inférieure s'applique pour la voie L avec égalisation du niveau à 50 Hz.

*3.3.2.4. Diaphonie*

La figure 10 illustre la diaphonie entre les deux voies. La voie R présente une dissipation de puissance de 6,7 W avec correction de tonalité en position médiane. La sensibilité en sens Y est réduite. L'entrée de la voie L est découplée par une impédance de 47 kΩ//220 pF (fig. 6). La troisième courbe supérieure illustre la diaphonie de la voie R à la voie L. Les deuxième et quatrième courbes s'appliquent pour une sortie de 0,1 W. Le diagramme prouve que la suppression de la diaphonie dépend de la fréquence. Elle varie de 30 à 50 dB environ en fonction de la gamme de transmission des ondes fondamentales (50 Hz à 15 kHz). Au-delà de 10 kHz la diaphonie croît rapidement, ce qui importe peu, car les amplitudes de ces fréquences sont relativement faibles pour la transmission de musique.
La diaphonie est la plus petite en fréquence moyenne. La diaphonie à faibles fréquences provient de la résistance limitée de l'alimentation commune.
A fréquence croissante la diaphonie croît également par suite des capacités et des inductances parasites.

Pour connecter la sortie PEN LIFT (levage de style) du PM 5165 de façon correcte aux enregistreurs X-Y Philips, consulter la table suivante:

| *PM 5165 (arrière)* | *Douille BNC Connexion centrale (+15 V)* | *Douille BNC Connexion extérieure (terre de signal)* |
|---|---|---|
| PM 8041 (Fond) | Fiche Amphenol connexion 2 | Fiche Amphenol connexion 1 |
| PM 8125 | BU101 connexion 2 | BU101 connexion 1 |
| PM 8132 | Fiche à 24-pôles connexion 11 | Fiche à 24-pôles connexion 21 ou 22 |
| PM 8141 | Fiche Amphenol connexion 2 | Fiche Amphenol connexion 1 |

Pour connexion de la sortie PEN LIFT à d'autres enregistreurs X-Y, se référer à la notice d'emploi et d'entretien du fournisseur.

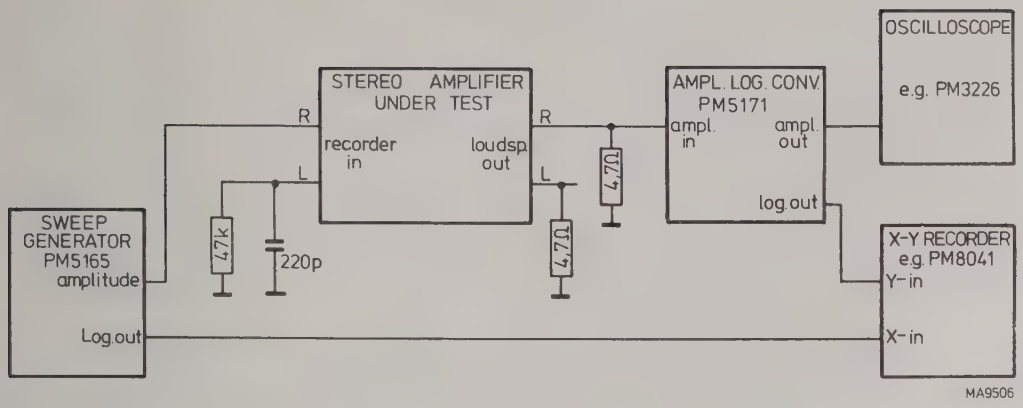



Fig. 6. Measuring set up, blockdiagram
Abb.6. Messanordnung, Blockschaltbild
Fig. 6. Disposition de mesure, schéma synoptique

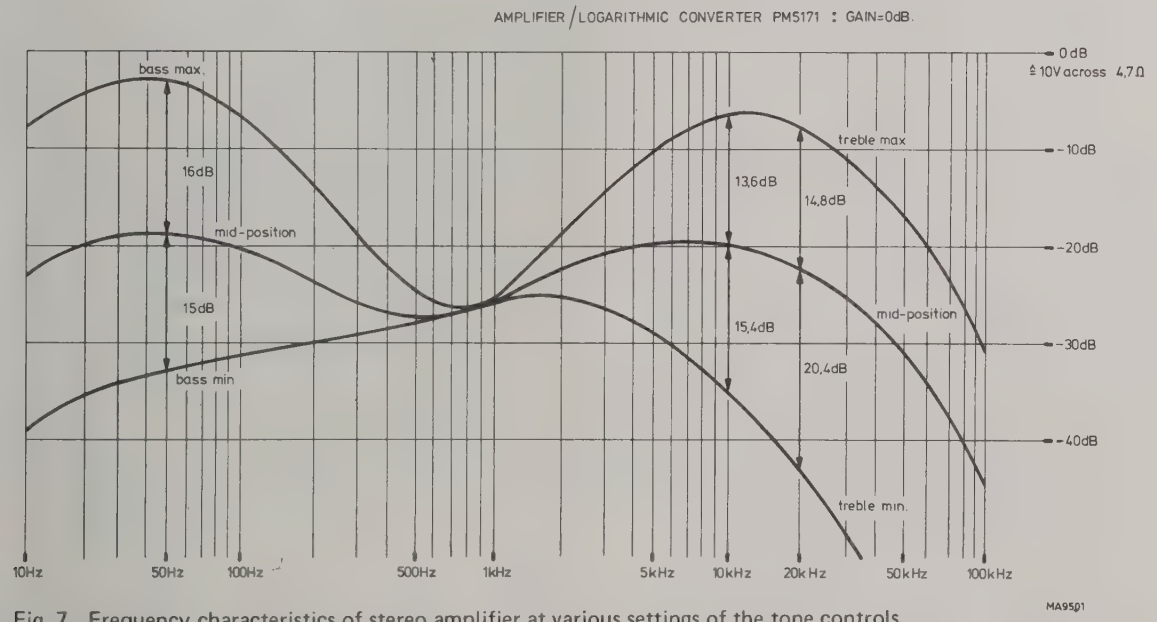



Fig. 7. Frequency characteristics of stereo amplifier at various settings of the tone controls
Abb.7. Frequenz Kennlinie des Stereoverstärkers bei verschiedenen Einstellungen des Klangregler
Fig. 7. Caractéristiques de fréquence d'amplificateur stéréo pour divers réglages de tornalité

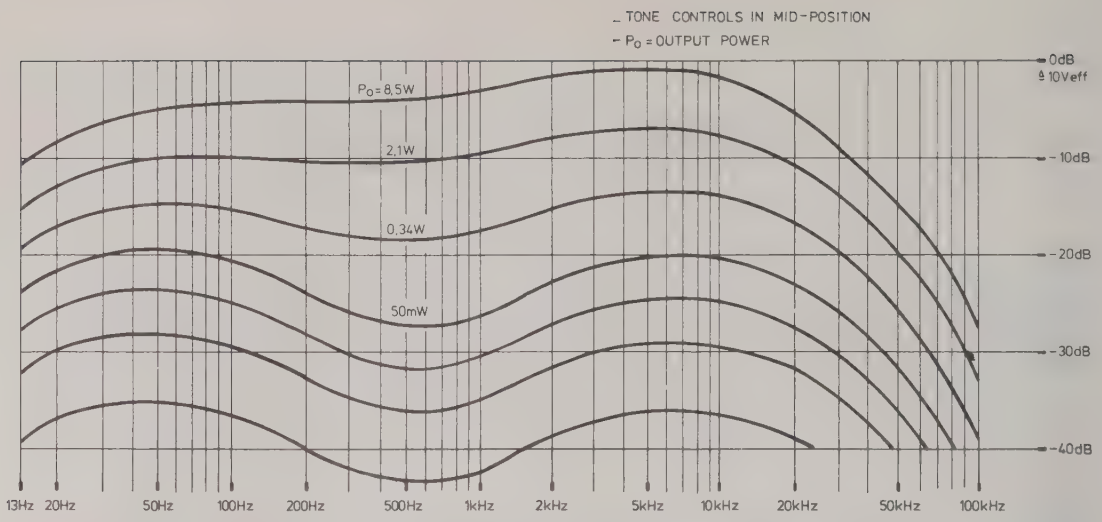



Fig. 8. Frequency characteristics of stereo-amplifier at various output powers
Abb.8. Frequenz Kennlinie des Stereoverstärkers bei verschiedener Ausgangsleistung
Fig. 8. Caracteristiques de fréquence d'amplificateur stéréo pour diverses puissances de sortie

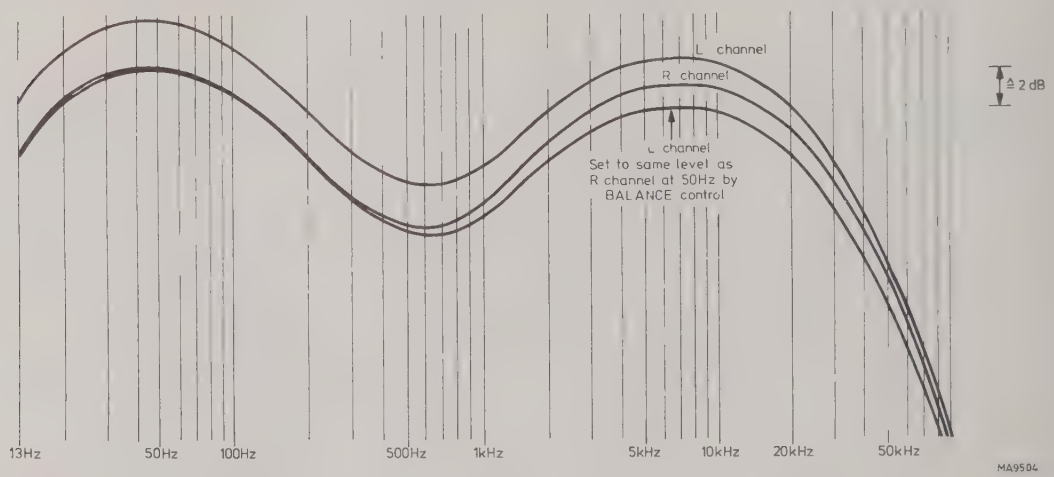



Fig. 9. Frequency characteristics of stereo-amplifier at various settings of the balance control
Abb.9. Frequenz Kennlinie des Stereoverstärkers bei verschiedenen Symmetrieeinstellungen im R-Kanal
Fig. 9. Caractéristiques de fréquence d'amplificateur stéréo pour divers réglages de balance

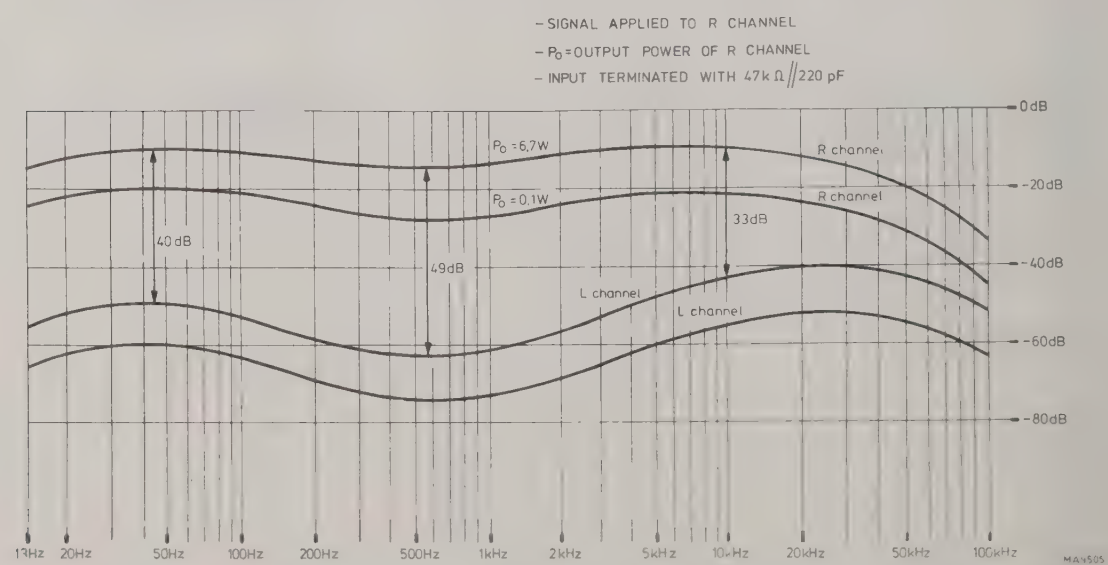



Fig. 10. Measurement of cross-talk from R to L channel at two different output powers in the R channel
Abb.10. Messung des Übersprechens von R- nach L-Kanal, bei zwei verschiedenen Ausgangsleistungen im R-Kanal
Fig. 10. Mesure de diaphonie de voie R à L à deux differentes puissances de sortie dans la voie R

# 4. SERVICE PART

## 4.1. CIRCUIT DESCRIPTION PM 5165

### 4.1.1. Sweep generator: sweep oscillator, switching circuitry

**General**

The sweep oscillator mainly consists of the integrating operational amplifier 405 with charging capacitor 523 and comparator 349. The SWEEP PERIOD control potentiometer 701 determines the charging current. For quick fly-back, transistor 347 is turned on, allowing the discharging current to flow through diode 449 to earth. HOLD-switch interrupts the charging path of the integrator, keeping the output voltage of 405 at the instant level. Potentiometer 706 determines the reference input voltage of the integrator. The charging current of the integrator results from the difference between this voltage and U charge (347 turned off) at 701 and 702. During charging the output of the integrator is decreasing from +4 V to 0 V, determined by comparator 349 and switching transistor 347.

The output of the integrator is fed via SWEEP RATIO $f_H/f_L$ control and inverting amplifier 406 to the main oscillator, where the voltage controls the frequency. 0 V represents the highest frequency $f_H$ of the main oscillator, −4 V corresponds to the lowest frequency $f_L$.

**SET $f_L$**

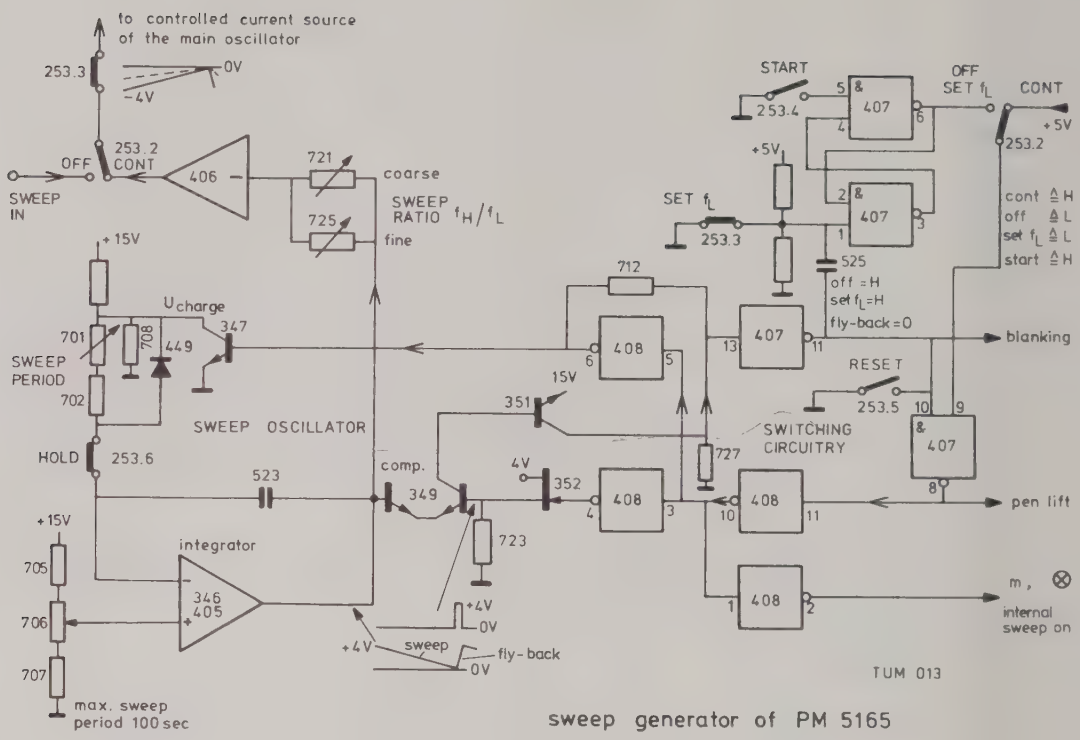
Pressed button SET $f_L$ resets the CONT switch thus feeding logical L from output 6 of flip-flop 407 via 407.9 to H at 408.4 and 408.6. So transistors 352 and 347 conduct. This first allows the discharging current to flow through diode 449 to earth, so that the output of the integrator flies to +4 V. In this moment comparator 349 works as differential amplifier; balanced voltage of transistor 351 is fed via 712 to transistor 347, the working point of which determines the same voltage at the collector as the negative reference of the FET input amplifier 346. So no current can change the charge of the capacitor. Voltage at 727 is too low so that 407.11 remains high. +4 V at the output of the integrator can be attenuated by SWEEP RATIO $f_H/f_L$, so that the lowest frequency of the sweep can be coarse and fine set by potentiometers 721 and 725 at the front panel.

**START (single sweep)**

SET $f_L$ enables the flip-flop 407 to be switched over by START switch 253.4. Pressing this button causes the oscillator to sweep for only one period:

407.6 goes high, 407.8 goes low for 407.10 was high before. By double inverting this low 408.4 and 6 are low too. The reference level of 349 is now zero and transistor 347 turns off. So the sweep starts; the output of the integrator decreases from +4 V to 0 V. At the level of 0 V the comparator changes the states, 351 turns on, input 407.13 goes high. Low at the output feeds a negative pulse to 407.1 resetting the flip-flop. Low at 407.10 and 9 force the generator to fly back to +4 V at the output remaining at this level as described above. Switching output 407.11 to high does not effect the flip-flop. A new sweep can be started by pressing the START button.

**RESET** short cuts 407.11 and resets the flip-flop. A new cycle can be released by START button. The generator remains in the same positions as if SET $f_L$ was pressed.




sweep generator of PM 5165

The **OFF**-switch resets the continuous switch and separates the sweep oscillator from the main oscillator. Hence the input of the latter is 0 V, representing the highest frequency, to be set by FREQUENCY $f_H$.

When the **CONTINUOUS** button is pressed gate 407.9 is permanently high, flip-flop 407 is out of action. 407.8 is enabled to switch to low at the end of the fly-back. So the reference level of the comparator is turned to 0 V and continuous sweep is possible.

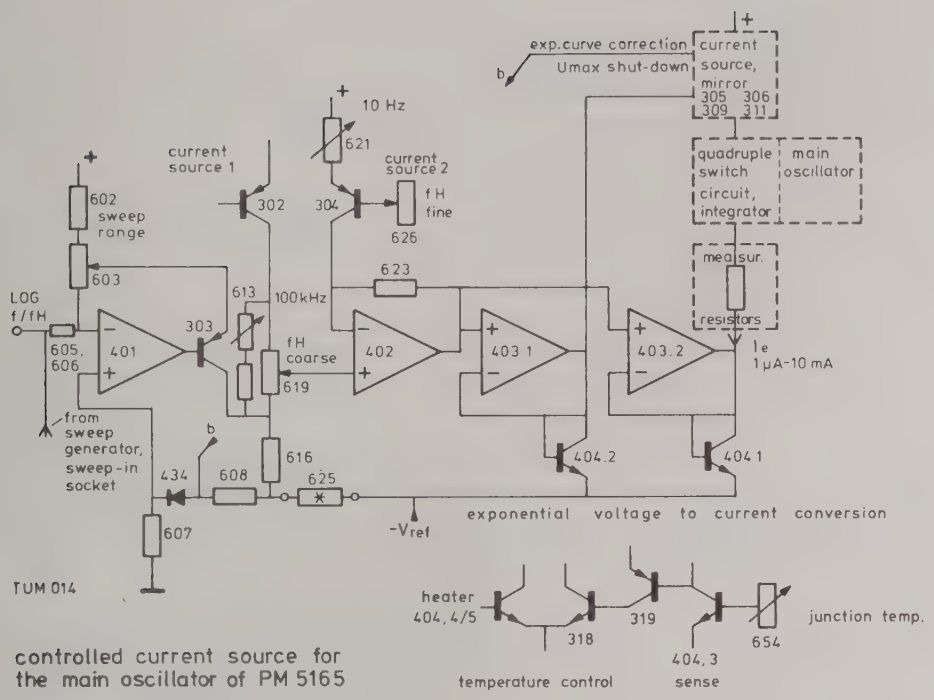
**Blanking, pen lift, internal sweep on:**

During fly-back, off or set $f_L$, gates 802.2 and 807.8 are high, so light emitting diode INT SWEEP ON blanks and output PEN LIFT opens. In addition during fly-back transistor 356 cuts off separating the OUTPUT from the WAVE FORM switches.

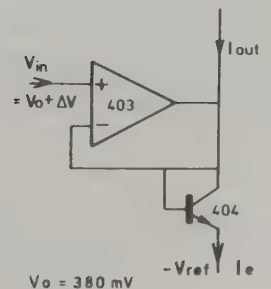
### 4.1.2. Controlled current source

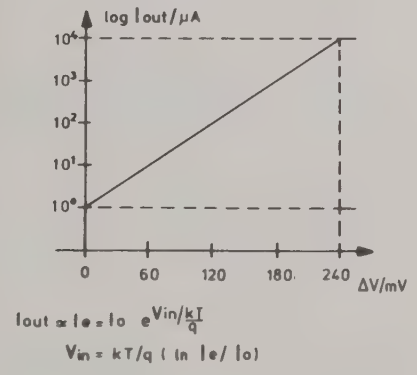
**General task** of the controlled current source is to convert voltages from the sweep oscillator or at the sweep input socket and of the two $f_H$ potentiometers into a current Ie of the integrator of the main oscillator. The relationship between input voltage and output current is exponential. As this conversion is temperature sensitive, a temperature control section had to be inserted.

The **input section** with operational amplifier 401 and transistor 303 as main components is designed as voltage to current converter. The output current varies the voltage drop over resistors 616 and 625, so shifting the reference voltage at the potentiometer combination 619, 613. 613 serves for internal adjustment. The voltage between the wiper of 619 and −Vref represents the instant current Ie and so the coarse frequency of the main oscillator.




controlled current source for the main oscillator of PM 5165




**Current source 2** generates an additional output voltage shift of amplifier 402 via resistor 623. The shift is done by FREQUENCY $f_H$ fine potentiometer and covers the range of ±10 % (0.9 ... 1.1 at the front panel control) of the instant $f_H$ frequency. Voltage of zener-diode 444 represents the reference of current source 1. To compensate for the temperature coefficient of the base-emitter path of transistor 302, the reference is sensed via diode-connected transistor 301. Since 301 and 302 are of the same type and lead equal current, the overall temperature coefficient of current source 1 is very low. For source 2 zener-diode 444 represents the reference too; transistor 333 is used as compensation diode. The source is adjusted by potentiometer 621 so that the output voltage of 402 results in a frequency of 10 Hz, when the $f_H$ coarse potentiometer is set to 10, $f_H$ fine to x1 of the scale and frequency multipl. x1.

The **expotential voltage to current converter** takes advantage of the logarithmic voltage-current relationship of the base-emitter junction of transistors 404.1/2, following the formula $V_{be} = kT/q \ln I_e/I_o$. This means that at 23 °C junction temperature a voltage difference of about 60 mV results in a current ratio of 10 : 1 when the diode connected transistor is connected in the output path of a voltage follower. So current Ie is an exponential function of the input voltage. The current range comprises 4 decades from 1 $\mu$A to 10 mA. The overall scale factor is1 decade $I_e$ per 1 V at the LOG $f/f_H$ socket.

Both halfs of the double operational amplifier 403 are designed as voltage followers. At the input of 403.2 high impedance and low drift is achieved by differential double FET 312. 403.1 controls the current of the positive current source, flowing out of the mirror 306, 309, 311 into the quadruple switch of the main oscillator.

Above 1 mA an additional term $R_b \times I_e$ to the exponential conversion formula has to be taken into account due to the spreading resistance in the base of the transistor. Compensation is achieved by feeding an additional current flowing out of the mirror via connection b to the $f_H$ potentiometer combination, where the additional voltage at resistor 625 increases the input voltage of amplifier 402. The second task of connection b is to limit the maximum current of $I_e$. At current values of approx. 13 mA, the voltage at resistor 608 rises to the forward voltage of diode 434. The diode conducts, so the positive voltage is generated by 607 at the positive input of amplifier 401, diminuing the voltage at 602 and collector output current of 303. So control voltage at 616 is reduced which leads to the maximum Ie of approx. 15 mA.

Significant temperature effects on the exponential formula have to be compensated: the coefficient kT/q and the leakage current Io, also called saturating current, which is doubled by each 10 °C temperature difference.

Constant temperature is achieved by the temperature control in which the dual-in-line transistor array 404 contains sense and heater transistors 404.3/4/5 together with the exponential transistors. Increase of the surrounding temperature leads to increase of the current of transistor 404.3 acting as sense stage in the circuitry. The control signal is fed to transistors 319, 318 and results in decrease of the heater current in 404.4/5. So the thermal loop is closed. By adjusting potentiometer 654, and thus the heater current, the operating junction temperature of the transistor array is set to approx. 85 °C.

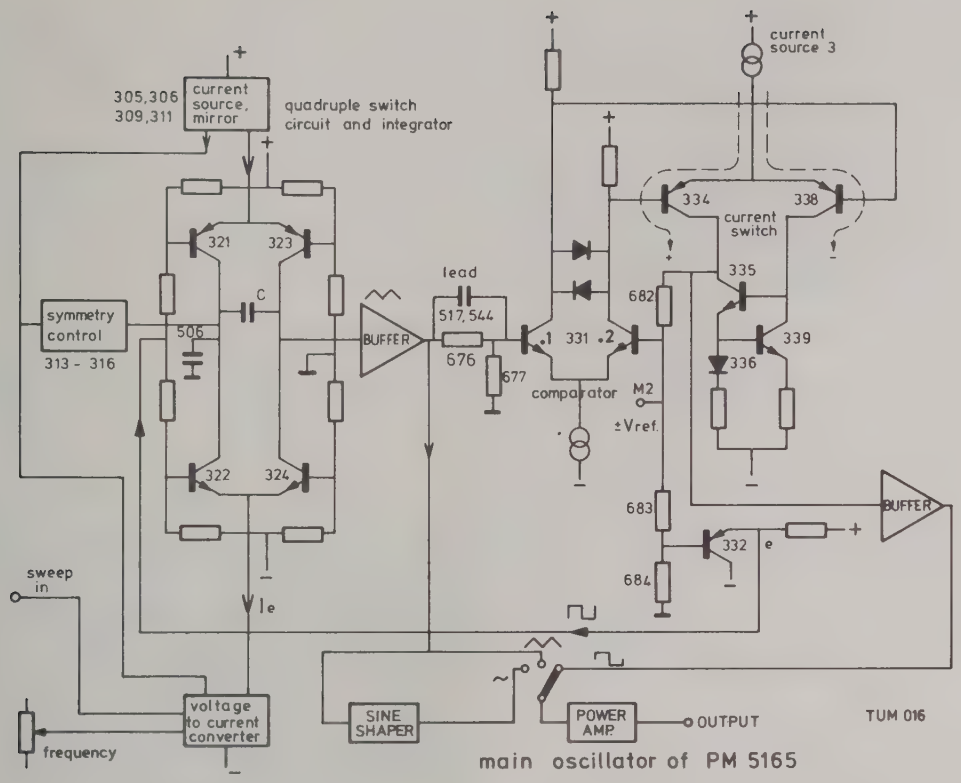
### 4.1.3. Main oscillator

**In general** the waveform generator operates on the relaxation oscillator principle whereby capacitor C is first charged linearly in one direction and then charged linearly in the reverse direction to produce a triangular waveform. The frequency is determined by the selected range capacitor C and the charging current, controlled by the exponential voltage to current converter.

Switchover of the charging current is achieved by a two-level detector or comparator circuit which produces a reference signal when C has charged to a predetermined level. This reference signal is fed back to reverse the charge through the capacitor by means of the quadruple switch circuit.

The circuit operates as follows:

Assume that point e is positive. The capacitor C will charge via 323 and 322 (321 and 324 are switched off). At a predetermined level, transistor 331.1 of comparator 331 will switch on and open the current switch 338. Current will flow from the current source 3 via 338, current mirror 339/336 and 335 to switch off the right-hand side of 331. A portion of the resulting negative voltage at M2 is routed via 332 to point e. With a negative voltage at point e, the quadruple switch circuit will switch over. Capacitor C will now be charged in the reverse direction via 321 and 324. At a negative predetermined level, transistor 331.1 will switch off and also the current switch 338. Current switch 334 will turn on because transistor 331.2 is in the "ON" state. 332 will now be cut off by the positive voltage on its base and point e will again be positive. In this way, the triangular waveform is generated, the frequency of which depending on the choice of the charging capacitor and the magnitude of the charging current. The square-wave is produced by 331.2 in conjunction with the current switches.




main oscillator of PM 5165

The basic part of the oscillator is the **quadruple switch** circuit with the frequency determining capacitors 508 – 512, selected by the front-panel pushbuttons FREQUENCY MULTIPL. Under the control of the squarewave signal at point e, at each half-cycle two diagonally opposite transistors open while the other two close (i. e. 323, 322 open, 321, 324 close, vice versa). In this way the direction of the charging current is changed. To produce a triangular waveform that is time-symmetrical with respect to earth, one side of the charging capacitor is connected to virtual earth at the gate input of FET 316. In this way, the triangular signal is taken from the active side of the charging capacitor with respect to the 0 V line.

The **symmetry control** circuit 313 to 316 was introduced to equalise for any inaccuracies caused by distortion and unbalance. On the virtual earth side of the selected charging capacitor, the capacitor 506 will be charged by any unbalance, because it is inserted between the charging capacitor and earth. This unbalance provides a control voltage for FET 316. The differential stage 313 to 316 operates as a voltage/current converter, the output either putting current into the current source or taking out of it depending on the state of the positive current control 403.1. By this means, and by transistors with high current gain (i.e. negligible leakage current) in the quadruple switch circuit, any unbalance of the two loading currents is equalized, so reducing time symmetry errors of the signal.

A high impedance FET **buffer** 325 avoids charging current variations occuring on the active side of the charging capacitor. Emitter follower 328 then connects the signal to the low-ohmic waveform switch circuit and the comparator 331.

To compensate for non-linearity in the frequency response of the highest range due to circuit delays in the comparator and the quadruple switch the **high-pass filter** network 516, 517, 544, 675 – 677 was inserted between the oscillator and the comparator.

The **comparator** 331 compares the instantaneous value of the capacitor charging potential against the reference level at point M2, which is ±2 V squarewave symmetrical. When the circuit attains one of the reference levels, it actuates the quadruple switch. At the same time, the comparator reference level is switched to the oposite polarity.

The reference voltage is derived from current source 3 comprising transistors 333, 337. For the +2 V positive reference, the constant current of the current source is routed via 334 directly to the resistance divider chain 682 – 684. The –2 V negative reference is derived via current switch 338 and is inverted by the current mirror 335, 336, 339. Consequently, on the reference side of the comparator, squarewave signals are generated by periodic switching of the reference current.

The squarewave signals are taken from the resistance divider as follows:

- via emitter follower 332, which serves as a buffer and feeds part of the squarewave output via point e to control the quadruple switches.
- the squarewave signal is routed, via buffer 341, 342, to the waveform switch that selects the triangular, sine or squarewave outputs.

**Current source 3** (444, 333, 337) supplies constant current to the reference side of the comparator and also to the frequency fH potentiometer. This circuit is chosen because current changes caused by drift in the reference elements produce antiphase effects in the comparator and frequency potentiometer. These effects compensate for the fact that the voltage developed across the potentiometer is directly proportional to the frequency, and that the reference voltage at the comparator is inversely proportional to the frequency.

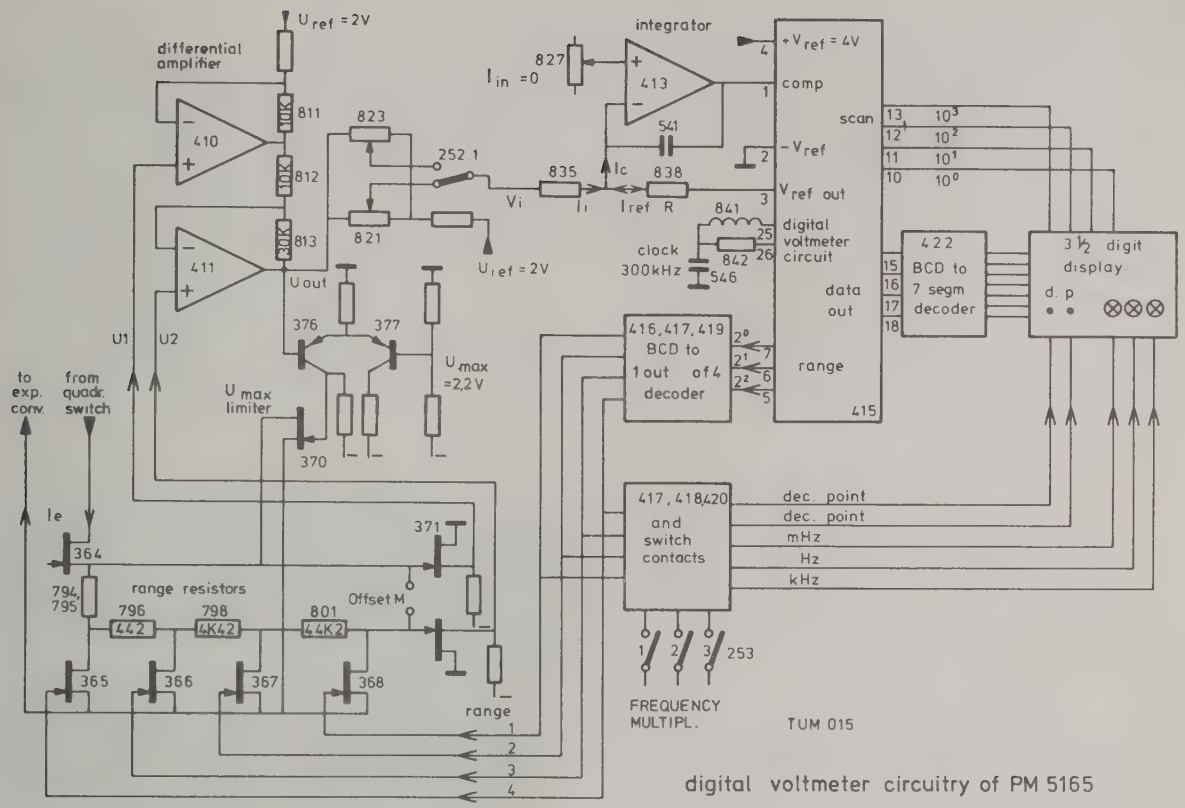
The triangular signal is fed via the waveform switch to the **sine shaper**, integrated circuit 409. The conversion from triangle to sinewave, with a distortion factor of 0.2 % typical, is achieved by nonlinear waveform shaping at a diode-resistor network in the IC. The peaks of the triangular waveform are suppressed by special compensating circuit in the integrated circuit.

Associated preset controls for shaping are potentiometer 757 and 763. The output, pin 1, is routed via a low-pass filter which serves to reduce the harmonic content of the sinewave at the highest frequencies. 765 provides a control adjustment for the amplitude response. The output d. c. offset is set to zero by 771. The emitter-follower 358 is used for impedance matching and d. c. shift. The output is fed via the waveform switch and blanking stage 356 and front-panel AMPLITUDE control 776 to the power amplifier and the OUTPUT socket.

In the **power amplifier** the AMPLITUDE potentiometer sets the level of the selected signal. The amplifier works as impedance converter, with input-emitter-follower 359 and White-emitter-follower 361 – 363. The output amplifier is short circuit proof.

### 4.1.4. Range resistors, differential amplifier

For digital frequency display the current flowing through the relevant condensator of the quadruple switch of the main oscillator is converted into voltages for the digital voltmeter circuit. This principle has the advantage of quick measurement of low frequencies even as low as 100 mHz. Current Ie is led to the range resistors 794, 795, 796, 798, 801. Only one of the relevant transistors 365 – 368 conducts permitting the current to flow either through 1 R, 10 R, 100 R or 1000 R. The resistors are switched by the automatic range control within the digital voltmeter circuit 415. Switching is carried out in such a way that the voltage difference at the gates of double FET 371 is not higher than 923 mV and not lower than 83 mV. These values represent 1999 resp. 0180 on the display. The drain voltage of the FETs is high-ohmic monitored by source follower 373. At the emitter of 374 the same potential serves as a reference voltage for switching the FETs. 3 of the 4 diodes 457 – 460 conduct at the same time cutting off the relevant FETs




digital voltmeter circuitry of PM 5165

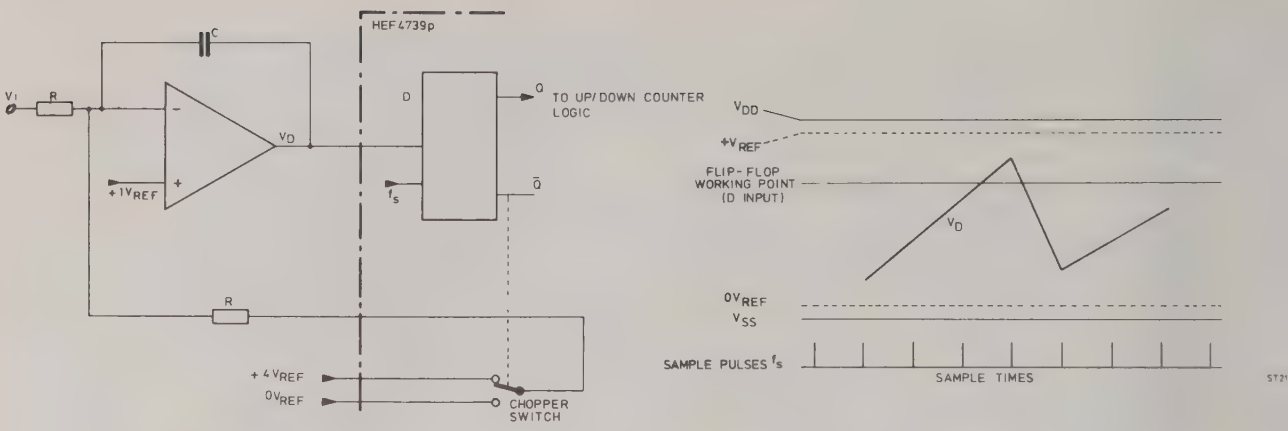
Passing the source-follower FET-pair 371, the measuring voltage is amplified by the differential amplifier 410, 411 due to the formula Uout = (1 + k) (U 2 – U 1), k = 813/812, so Uout = 4 (U 2 – U 1). One measuring cycle of the DVM lasts about 200 msec and automatic range switching cannot be done faster. When operating at short sweep periods (1 sec) the difference U 1 – U 2 would rise to unacceptable high values. To prevent this, comparator 376, 377 turns on transistor 370, if U 1 – U 2 exceeds 1.1 V. Thus the measuring voltage is limited to this value.

### 4.1.5. Digital voltmeter circuit

**Principle**

The analogue to digital converter is designed to convert the d. c. voltage from the analogue section into a digital form, suitable for display and range changing purposes.

The 2 V d. c. end-of-range from the analogue section is passed to the ADC where it is compared with a switched reference voltage. The resultant voltage is used to charge a capacitor in the integrator circuit 413 to produce a sawtooth voltage. Thus the sawtooth changes state at a point dependent upon the magnitude of the input voltage. Pulses from a programme clock that sample the capacitor charge time provide a digital representation of the analogue input. These pulses are counted in a 4-decade up/down counter and transferred to a buffer memory, and the counter is reset for the next conversion. A multiplexer routes each decade to the decoder driver 422. The 7-segment signals are applied to all four of the displays, but only the appropriate anode switch is activated by the counter. The number of pulses from the up/down counter is sampled in a result detector to determine when ranging should occur.




**Details**

The ADC in the GZF 1200 D, equal to the type HEF 4739 P in the DVM PM 2513 A, is based on the principle of delta-pulse modulation. This integrating system ensures good linearity and series mode rejection. In addition, the circuit contains a minimum of critical elements, the accuracy of the ADC being dependent only on the accuracy of the reference voltages. The output of flip-flop FF operates a chopper switch to connect the negative input of the integrator via R to either a positive or a negative reference voltage. The state of the flip-flop depends on the level of the D input at the time of a sample pulse fs. In turn, the level of the D input depends on the state of charge of capacitor C.

Assume that, at the instant of a pulse fs, the voltage level at D is below the flip-flop working point. This results in a low output from the chopper and a negative reference voltage is connected to R. The input voltage Vi and the reference voltage Vref are both applied to the integrator/comparator. Because Vref is greater than Vi within the scale range, the integrator output voltage increases and is given by:

$$VD_c = \frac{1}{RC} (V_i - V_{ref})\, tc \qquad (1)$$

where tc is the charging time.

At each succeeding sample pulse $f_s$, VD is sampled and when VD exceeds the flip-flop working point the flip-flop changes its state.

The integrator is then connected to the +Vref, its output falls and is given by:

$$VD_d = \frac{1}{RC} (V_i + V_{ref})\, td \qquad (2)$$

where td is the discharge time.

It is seen that providing Vi is greater than 0 the slope resulting from equation (2) is greater than that resulting from equation (1). Since Vref is greater than Vi, these equations show that the sign of the slope changes when the chopper is switched. Thus the integrator output is a sawtooth waveform.

From the equations, it can also be deduced that for a negative input the slopes are reversed; i. e. the positive slope becomes the faster. The digitised feedback limits the charge in the capacitor C so that a charge balance is obtained between the input voltage and the reference voltage. From the compensation method the average value VD (VDc + VDd) will be equal to Vi.

Consequently:

$$V_i = \frac{tc - td}{tc + td} V_{ref} \qquad (3)$$

where tc + td = tm (measuring time).

Assuming:

N = total number of pulses fs during tm
n = total number of pulses fs during tc

Then equation (3) can be written as:

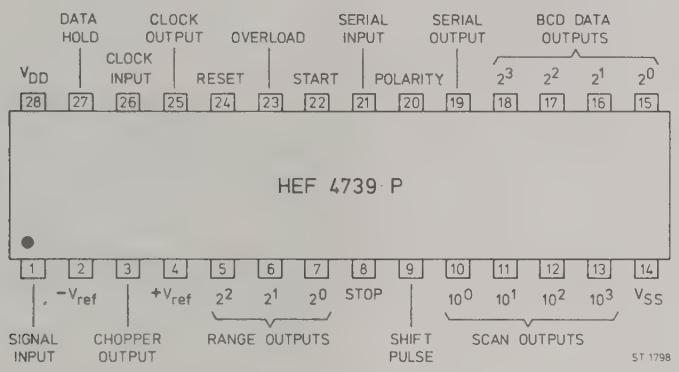
$$V_i = \frac{n-(N-n)}{N} V_{ref} \qquad V_i = \frac{2n-N}{N} V_{ref} \qquad (4)$$

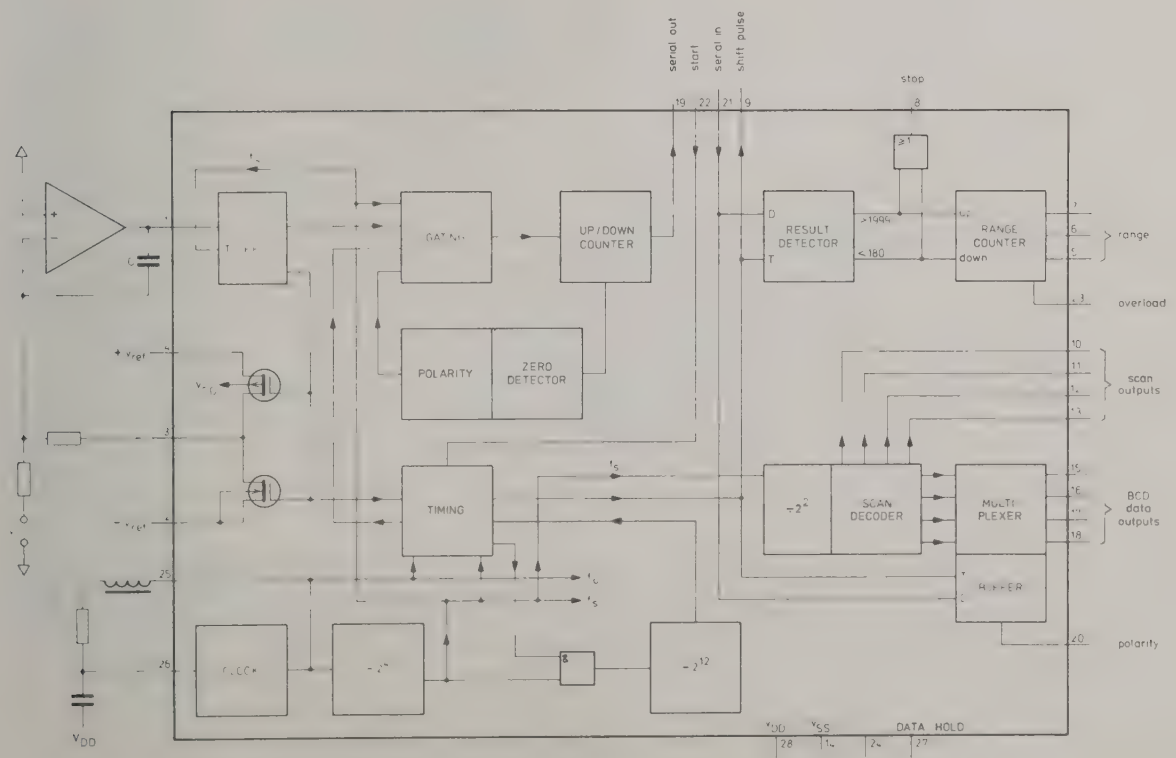
Since an up/down counter is used to count up when +Vref is connected to the integrator, after N sample times the contents of the counter will be 2n − N.

This counter includes polarity and zero detecting sections and counts the absolute value of 2n − N by shifting the counter contents at clock rate through an adder circuit that adds one binary up or down according to the state of Q and the polarity. At the end of the measuring period, the counter content (together with polarity) is serial-shifted out, at clock rate $f_o$, at pin 19 in synchronism with the shift pulses at pin 9. The serial data is organized as follows in NBCD code.

most significant bit = last bit out
least significant bit = first bit out

| bit no. | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| data | POL | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | X |
| | $10^3$ | | | $10^2$ | | | | 10 | | | | 1 | | | | |



In the integrated circuit block N = 4096 and +Vref = +4 V, −Vref = 0 V. The figure shows the internal functions of the block. To obtain a stable display, the contents are divided by two and transferred into a memory, after which the counter is reset. A new measurement can start. Within the circuit block a multiplexer alternately connects each decade of the memory to the decoder driver. At the same time, a pulse is generated to drive the anode switch of the associated 7-segment "LED". The decoded information is then transferred via the decoder driver to the indicator "LED's", the cathodes of which are connected in parallel.

Only the indicator with the anode switch closed will light. If the pulse count exceeds 1999, the range counter will take the next more significant range and a new measuring cycle is automatically started. Down-ranging is effected at or below 0180 pulses, counted during one measuring cycle. Permitting the difference of Ii − Iref to be very small, source follower dual FET 378 gives a high input resistance and low offset drift. This configuration eliminates the need for bias current adjustment.

Offset correction of 378 and 413 are effected by means of potentiometer 827 which is adjusted with the DVM input shorted by means of link M. In this case 541 is symmetrically charged and discharged during the time of 2048 pulses each. Potentiometer 821, 823 adjust the scale factor of the circuitry. This is required for tolerances (1 %) of the charging capacitors 508, 509 in the quadruple switch of the main oscillator. 823 serves for 508 (frequency multipl. x 0.01), 821 for 509 (x1) and 511, 512 (x10), whereby 512 adjusts the effective capacity to 1/10 of 509.

The DVM has automatic range changing capability of up to 8 ranges, 4 of which are made use of. Binary outputs 7, 6, 5 are connected to the 1 of 4 decoder, which consists of gate and inverter combination 416, 417, 419. The valid range shows logic zero (L) opening only one of the range FETs 365 − 368. Depending on whether the BCD output data is greater than 1999 or less than 0180, the range counter counts up 1 step or down 1 step respectively.

The ranges are gated and coupled by the frequency multipl. x0.01, x1, x10 switch contacts for proper indication of the 2 floating decimal points and the dimension mHz, Hz, kHz.

**States of range gates:**

| | 415. | | | 419. | | | | | 416. | | | | 417. | | | | 418. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| range | .5 | .6 | .7 | .2 | .4 | .6 | .10 | .8 | .3 | .11 | .8 | .6 | .6 | .8 | .11 | .3 | .11 | .3 | .8 |
| 1 | L | L | L | H | H | H | L | L | L | H | H | H | L | H | L | H | L | H | L |
| 2 | L | L | H | H | H | L | L | H | H | L | H | H | L | H | L | L | H | L | L |
| 3 | L | H | L | H | L | H | H | L | H | H | L | H | L | H | H | L | L | L | H |
| 4 | L | H | H | H | L | L | H | H | H | H | H | L | H | L | L | H | L | L | H |

**Display in different ranges:**

| | FREQUENCY MULTIPL. | | |
|---|---|---|---|
| range* | x0.01 | x1 | x10 |
| 1 | 0100 mHz − 1999 mHz | 010.0 Hz − 199.9 Hz | 0100 Hz − 1999 Hz |
| 2 | 02.00 Hz − 19.99 Hz | 0200 Hz − 1999 Hz | 02.00 kHz − 19.99 kHz |
| 3 | 020.0 Hz − 199.9 Hz | 02.00 kHz − 19.99 kHz | 020.0 kHz − 199.9 kHz |
| 4 | 0200 Hz − 1000 Hz | 020.0 kHz − 100.0 kHz | 0200 kHz − 1000 kHz |

* FREQUENCY fH control turned clockwise

The **clock** frequency is determined by external R − C − L combination to 300 kHz at pin 25, 26 of the DVM. The clock has not to be very stable, for tolerances and drifts are eliminated due to the delta-modulation principle. +Vref for the DVM consists of diode 465 with voltage divider 836, 837 and voltage follower 412. The tolerance of Vref is also corrected by potentiometer 821, 823.

## 4.2. ACCESS TO THE PARTS

### 4.2.1. Cabinet

The upper and lower plates are fixed to the rear by means of 2 screws each.

### 4.2.2. Knobs

- Remove the cap from the knob
- Unscrew the nut and remove the knob
- When mounting the knob back, make sure that the white marks appear at the correct side

### 4.2.3. Textplate

- Remove upper and bottom plate
- Remove all knobs
- Carefully remove the ornamental frame
- Remove the textplate

### 4.2.4. Replacing a switch of the push-button unit

- Straighten the 4 retaining lugs of the relevant switches as shown in fig. 11.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-wiring board.
- Bend the 4 retaining lugs back to their original positions.

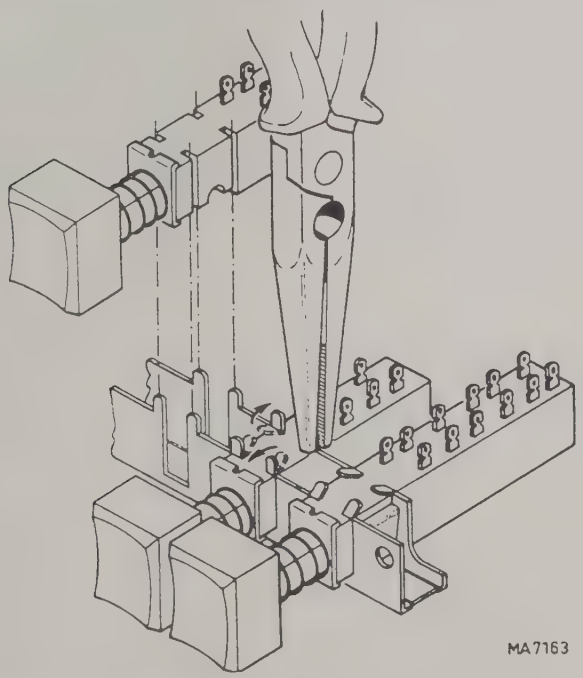



Fig. 11. Replacing a push-button switch

## 4.3. CHECKING AND ADJUSTING

– The tolerances mentioned in this chapter are valid only for a readjusted instrument and therefore might deviate from the values as stated in chapter 1.2. TECHNICAL DATA.

– Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of (+23 ± 5)°C and with (230 ± 11.5)V mains in a closed cabinet, if required the instrument must be warmed up again, after an adjustment operation.

– If not explicitly stated otherwise the voltage-potentials refer to the contact mentioned in respect of circuit earth ( ⊥o ).

– The following abbreviations are used for settings and measuring instruments:

| | | |
|---|---|---|
| X | = | Button pressed |
| – | = | Button not pressed/unlocked |
| o | = | Button only tipped |
| DM | = | Digital multimeter, e.g. PM 2424 |
| DV(dc) | = | Digital voltmeter for d.c. measurements e.g. PM 2443 |
| D | = | Distortion meter e.g. HP 333A |
| Osc. A/B | = | Oscilloscope e.g. PM 3226 (channel A/channel B) |
| P (dc) | = | DC power supply e.g. PE 1510 |
| V (ac) | = | AC voltmeter (see note 1) |
| V (dc) | = | DC voltmeter e.g. PM 2434 |
| C | = | Counter e.g. PM 6604 |
| 50 Ω | = | 50-Ω-termination resistance |

1) Note:

For the measurements in Seq. 39 and 40 it is recommended to use a peak rectifier and a DV(dc) in place of a V(ac).
Fig. 12 shows the circuit for the peak rectifier.

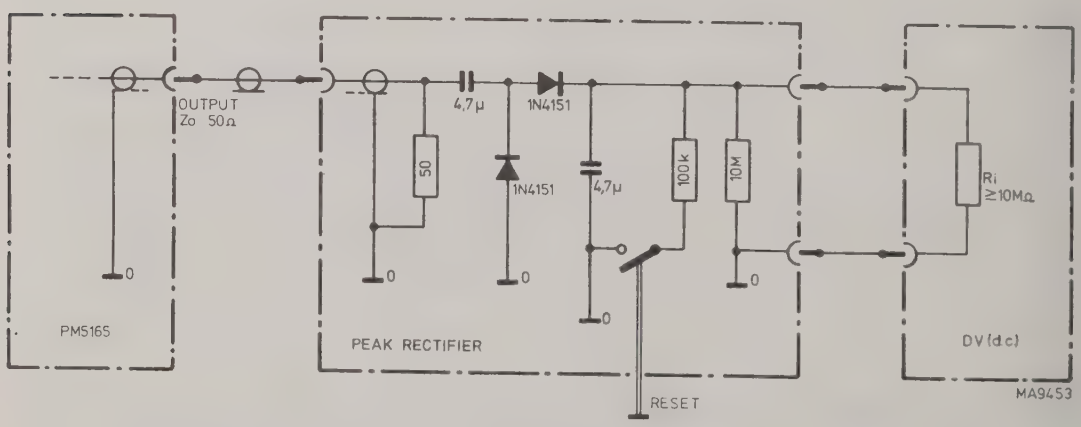
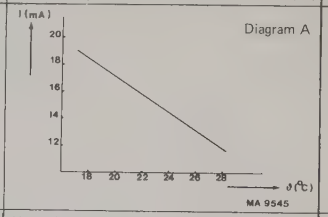



Fig. 12. Peak detector circuit

| Seq | SETTING | | | | | | | | | | | | | | | | | | | | MEASURING | | | ADJUST-MENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PUSH-BUTTONS | | | | | | | | | | CONTROLS | | | | | | SOCKETS | | | | | | | |
| | FREQ. MULTIPL. | INT SWEEP CONTROL | | | | | | WAVEFORM | | | FREQ. | FREQ. ±10 % | SWEEP RATIO | S R ±10 % | SWEEP PERIOD | AMPLI-TUDE | SWEEP IN | LOG $f/f_H$ | OUT-PUT | PEN LIFT | Measuring point | Measuring value | Explanation | Position no. |
| | 252/ | OFF 253/1 | CONT 253/2 | SET $f_L$ 253/3 | START 253/4 | RESET 253/5 | HOLD 253/6 | 253/7 | 253/8 | 253/9 | 619 | 626 | 721 | 725 | 701 | 776 | 202 | 201 | 203 | 204 | | | | |
| 1 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 555 (+) | U = + (4,75 ... 5,25) V | Set 230 V mains voltage to 196 V and 265 V respectively. The d.c. voltage U, must not deviate more than 0,1 V from the values measured at 230 V. Measure with DV (dc) | – |
| 2 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 558 (+) | U = + (15 ± 0,1) V | | 887 |
| 3 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 557 (–) | U = –(30 ± 0,1) V | | 891 |
| 4 | open soldered joint C and connect DM<br>x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | M1/Unit 1 | Set I in accordance with room temperature, $\vartheta$ see diagram A. | Diagram A<br>  | 654 |
| | close soldered joint C, remove DM | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | x0,01 | x | | | | | | | x | | 10 | | | | | | | | | | M2/Unit 1 | $U_{pp}$ = (4,64 ±0,02) V | $U_{pp} = U_{pos} + U_{neg}$ measured with DV(dc) | 689 |
| 30 | x0,01 | x | | | | | | x | | | 100 k | | | | | max. | | | 50 Ω D | | OUTPUT | D < 0,3 % | | – |
| 31 | x10 | x | | | | | | x | | | 100 | | | | | max. | | | 50 Ω D | | OUTPUT | D < 0,7 % | | – |
| 32 | x10 | x | | | | | | x | | | 30 k | | | | | max. | | | 50 Ω D | | OUTPUT | D < 1,5 % | | – |
| 33 | x1 | x | | | | | | x | | | 1 k | | | | | max. | | | V(dc) | | OUTPUT | U < 10 mV | | 771 |
| 34 | x1 | x | | | | | | | | x | 1 k | | | | | max. | | | V(dc) | | OUTPUT | U < 10 mV | | 696 |
| 35 | x1 | x | | | | | | | | x | 100 k | | | | | max. | | | 50 Ω Osc. | | OUTPUT | Overshoot + ringing < 1,5 % (in respect of $U_{pp}$) | | |
| 36 | x1 | x | | | | | | | | x | 1 k | | | | | max. | | | 50 Ω Osc. | | OUTPUT | $U_{pp}$ = (3 ± 0,3) V | | |
| 37 | x1 | x | | | | | | | x | | 1 k | | | | | max. | | | 50 Ω Osc. | | OUTPUT | $U_{pp}$ = (3 ± 0.3) V | | – |
| 38 | x1 | x | | | | | | x | | | 1 k | | | | | max. | | | 50 Ω Osc. | | OUTPUT | $U_{pp}$ = (3 ± 0,3) V | | – |
| 39 | x1<br>x10 | x | | | | | | x | | | 1 k<br>100 k | | | | | max. | | | 50 Ω V(ac) | | OUTPUT | $U_{pp} = U_{1kHz}$ ± 0,5 % | Note the value of amplitude $U_{1\ kHz}$<br>For V(ac) use for example peak rectifier + DV (dc)<br>For circuit refer to Fig. 12 | 765 |
| 40 | x10 | x | | | | | | x | | | 100... 100 k | | | | | max. | | | 50 Ω V(ac) | | OUTPUT | $U_{pp} = U_{1kHz}$ ± 2,5 % | | – |
| 41 | x1 | x | | | | | | x | | | 1 k | | | | | min/ max. | | | 50 Ω Osc. | | OUTPUT | Attenuation of $U_{pp}$ = (35 ± 5) dB | | – |
| 42 | x10 | (x) | | (x) | | | | | x | | 100 k | | $10^4$ | | | | | | | | OUTPUT | | This sequence has to be checked if balance of collector currents of Pos. 307, 317 might have been altered during repair; measurement may be done in an open cabinet. There has to be a triangle wave of the correct frequency immediately after switching from OFF to SET $f_L$. Otherwise trimming resistor 630 (printed wiring side, parallel to 629) must be changed to the highest possible value at which the desired effect can be achieved. | |

## 4.3. CHECKING AND ADJUSTING

- The tolerances mentioned in this chapter are valid only for a readjusted instrument and therefore might deviate from the values as stated in chapter 1.2. TECHNICAL DATA.
- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of (+23 ± 5)°C and with (230 ± 11.5)V mains in a closed cabinet, if required the instrument must be warmed up again, after an adjustment operation.
- If not explicitly stated otherwise the voltage-potentials refer to the contact mentioned in respect of circuit earth ( ⊥o ).
- The following abbreviations are used for settings and measuring instruments:

| | | |
|---|---|---|
| X | = | Button pressed |
| — | = | Button not pressed/unlocked |
| o | = | Button only tipped |
| DM | = | Digital multimeter, e.g. PM 2424 |
| DV(dc) | = | Digital voltmeter for d.c. measurements e.g. PM 2443 |
| D | = | Distortion meter e.g. HP 333A |
| Osc. A/B | = | Oscilloscope e.g. PM 3226 (channel A/channel B) |
| P (dc) | = | DC power supply e.g. PE 1510 |
| V (ac) | = | AC voltmeter (see note 1) |
| V (dc) | = | DC voltmeter e.g. PM 2434 |
| C | = | Counter e.g. PM 6604 |
| 50 Ω | = | 50-Ω-termination resistance |

1) Note:

For the measurements in Seq. 39 and 40 it is recommended to use a peak rectifier and a DV(dc) in place of a V(ac).
Fig. 12 shows the circuit for the peak rectifier.

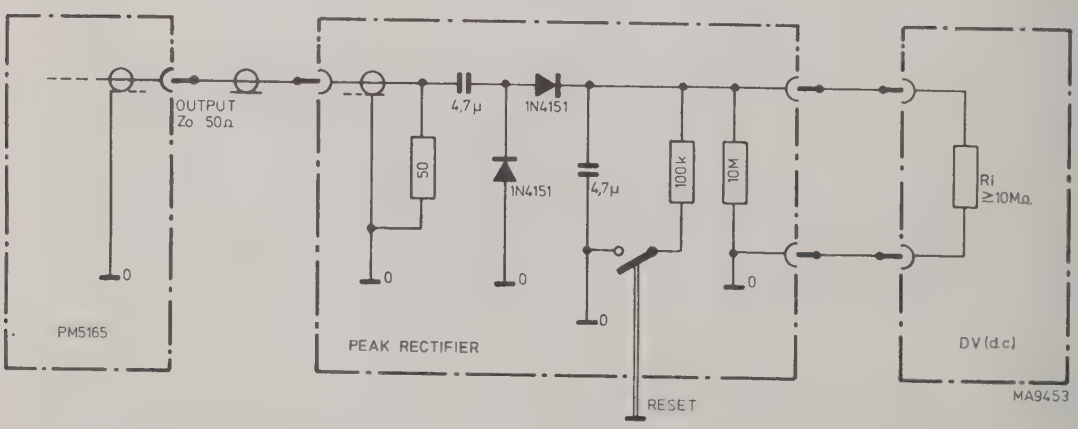
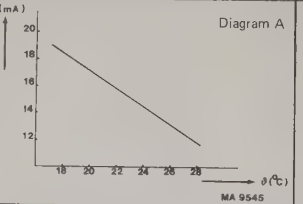



Fig. 12. Peak detector circuit

| Seq | SETTING: PUSH-BUTTONS: FREQ. MULTIPL | INT SWEEP CONTROL: OFF | INT SWEEP CONTROL: CONT | INT SWEEP CONTROL: SET $f_L$ | INT SWEEP CONTROL: START | INT SWEEP CONTROL: RESET | INT SWEEP CONTROL: HOLD | WAVEFORM | | | SETTING: CONTROLS: FREQ. | FREQ. ±10 % | SWEEP RATIO | SR ±10 % | SWEEP PERIOD | AMPLI-TUDE | SETTING: SOCKETS: SWEEP IN | LOG $f/f_H$ | OUT-PUT | PEN LIFT | MEASURING: Measuring point | Measuring value | Explanation | ADJUST-MENT: Position no. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 252/ | 253/1 | 253/2 | 253/3 | 253/4 | 253/5 | 253/6 | 253/7 | 253/8 | 253/9 | 619 | 626 | 721 | 725 | 701 | 776 | 202 | 201 | 203 | 204 | | | | |
| 1 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 555 (+) | U = + (4,75 ... 5,25) V | Set 230 V mains voltage to 196 V and 265 V respectively. The d.c. voltage U, must not deviate more than 0,1 V from the values measured at 230 V. Measure with DV (dc) | – |
| 2 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 558 (+) | U = + (15 ± 0,1) V | | 887 |
| 3 | x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | Cap. 557 (-) | U = - (30 ± 0,1) V | | 891 |
| 4 | open soldered joint C and connect DM<br>x1 | x | | | | | | | | | 10 k | | | | | max. | | | 50 Ω | | M1/Unit 1 | Set I in accordance with room temperature, $\vartheta$ see diagram A. | Diagram A<br>  <br> | 654 |
| | close soldered joint C, remove DM | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | x0,01 | x | | | | | | | x | | 10 | | | | | | | | | | M2/Unit 1 | $U_{pp}$ = (4,64 ±0,02) V | $U_{pp} = U_{pos} + U_{neg}$ measured with DV (dc) | 689 |
| 6 | x1 | | | | | | | | | x | 1 k | | | | | | | | | | FREQUENCY display | f = 000.0 | Interconnect both soldering points M3<br>Disconnect again after adjustment | 827 |
| 7 | x1 | x | | | | | | | | x | ~1k75 | | | | | | | | C | | FREQUENCY display OUTPUT | f = 1750 Hz | Set the frequency on the counter to 1,7500 kHz by means of Pos 619 and 626 then adjust with Pos. 821 the frequency display to the same value | 619, 626<br>821 |
| 8 | x0,01 | x | | | | | | | | x | ~1k75 | | | | | | | | C | | FREQUENCY display OUTPUT | f = 17.50 Hz | Set with Pos. 619 and 626 the period duration on the counter to 57,143 ms, then set the FREQUENCY-display to 17,50 Hz by means of Pos. 823 | 619,626<br>823 |
| 9 | x10 | x | | | | | | | | x | ~1k75 | | | | | | | | C | | FREQUENCY display OUTPUT | f ~ 17,50 kHz | Set the FREQUENCY-display to 17,50 kHz by means of Pos 619 and 626, then adjust with Pos 512 the frequency on the counter to the same value | 619, 626<br>512 |
| 10.1 | x1 | x | | | | | | | | x | 1 k | 1/1.1 | | | | | | | | | FREQUENCY-display | $\Delta f_1 \geq 80$ Hz | $\Delta f_1 \approx \Delta f_2$, if required readjust the knob FREQUENCY $f_H$ Hz fine on the axis | – |
| 10.2 | x1 | x | | | | | | | | x | 1 k | 1/0.9 | | | | | | | | | FREQUENCY display | $\Delta f_1 \geq 80$ Hz | | |
| 11 | x1 | x | | | | | | | | x | 10 | 1 | | | | | | | | | FREQUENCY display | f = 010.0 Hz | | 621 |
| 12 | x1 | x | | | | | | | | x | 10 | 1 | | | | | | | C | | OUTPUT FREQUENCY dispay | T = (100 ± 0.2) ms | Set with controls FREQUENCY the display to 010,0 Hz, than adjust with Pos. 800 the period duration on the counter | 800 |
| 13.1 | x1 | x | | | | | | | | x | 10 | 1 | | | | | P(dc) $U_{sweep}$ | | | | FREQUNCY display | f = 10.00 kHz | Set with a positive d.c. voltage $U_{sweep}$ the frequency indication to 10,00 kHz (ca. +3 V). Measure the voltage exactly! | – |
| 13.2 | x1 | x | | | | | | | | x | 10 | 1 | | | | | $U_{sweep}$ + 1/3 $U_{sweep}$ | | | | FREQUENCY display | f = (100 ± 5) kHz | $U_{sweep}$ + 1/3 $U_{sweep}$ = voltage $U_{sweep}$ from Seq. 13.1 increased by 1/3<br>f too large → reduce value Pos. 625<br>f too small → increase value Pos. 625 | 625 |
| 14 | x1 | x | | | | | | | | x | 100 k | 1 | | | | | | | | | FREQUENCY display | f = (100.0 ± 1) kHz | Set control FREQUENCY $f_H$ Hz exactly to mark 100 k.<br>Adjust FREQUENCY-display with Pos.613 | 613 |
| 15 | x1 | x | | | | | | | | x | 10 ... 100 k | | | | | | | | C | | FREQUENCY display OUTPUT | f = $f_o$ ± 0,9 % ± 1 digit | Compare FREQUENCY-display at all Scale-markings with value $f_o$ on the counter | – |
| 16 | x10 | x | | | | | | | | x | 100 k | | | | | | | | C | | FREQUENCY display OUTPUT | f = 1 MHz ±0,5 %<br>f = $f_o$ ±0,9 % ±1 digit | Compare FREQUENCY-display at all Scale-markings in range x 10 with value $f_o$ on counter | 544 |
| 17.1 | x1 | | | x | | | | | x | | 100 k | | $10^2$ | 1/1,1 | | | | | | | FREQUENCY display | $\Delta f_1 \geq 80$ Hz | $\Delta f_1 \approx \Delta f_2$, if required readjust the control | |

| | | |

## 4.4. CHECKS AFTER REPAIR AND MAINTENANCE

**Checking the protective leads**

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet.
The resistance should be $< 0.5\ \Omega$. During measurement the mains cable should be moved. Resistance variations indicate a defect.

**Checking the insulating resistance**

Measure the insulating resistance at $U_{_} = 500$ V between the mains connection and the protective lead connection.
To this purpose set the mains switch to ON.
The insulating resistance should be $> 2\ M\Omega$.

## 4.5. PARTS LIST

### 4.5.1. Mechanical

| *Item* | *Fig.* | *Quantity* | *Order number* | *Description* |
|---|---|---|---|---|
| 1 | 13 | 1 | 5322 498 54032 | Handle assembly |
| 2 | 13 | 2 | 5322 535 74367 | Spindle for handle |
| 3 | 13 | 2 | 5322 498 74003 | Cap for handle |
| 4 | 13 | 1 | 5322 447 94351 | Top cover |
| 5 | 13 | 1 | 5322 447 94351 | Bottom cover |
| 6 | 13 | 4 | 5322 462 44121 | Foot |
| 7 | 13 | 4 | 5322 492 64338 | Spring for foot |
| 8 | 13 | 4 | 5322 414 74014 | Cap for knob |
| 9 | 13 | 2 | 5322 414 74015 | Cap for knob |
| 10 | 14 | 4 | 5322 462 34152 | Mounting support |
| 11 | 13 | 2 | 5322 460 64003 | Ornamental strip |
| 12 | 14 | 1 | 5322 520 34138 | Bearing bush, left |
| 13 | 14 | 1 | 5322 520 34139 | Bearing bush, right |
| 14 | 13 | 1 | 5322 455 74057 | Text plate |
| 15 | 13 | 1 | 5322 460 64002 | Ornamental frame |
| 16 | 13 | 4 | 5322 414 34082 | Control knob |
| 17 | 13 | 2 | 5322 414 34075 | Control knob |
| 18 | 14 | 1 | 5322 447 94363 | Insulating cover |
| 19 | 13 | 12 | 5322 414 25507 | Pushbutton |
| 20 | 14 | 4 | 5322 532 64214 | Insulating disk |
| 21 | 13 | 4 | 5322 532 50824 | Insulating bush |
| 22 | 13 | 4 | 5322 267 10004 | BNC connector |
| 23 | 13 | 1 | 5322 276 14128 | Mains switch |
| 24 | 14 | 1 | 5322 325 50101 | Strain relief grommet |
| 25 | 15 | 1 | 5322 462 44172 | Cover for IC'423 |
| 26 | 15 | 2 | 5322 325 30009 | Ceramic tube |
| 27 | 15 | 1 | 5322 532 64214 | Insulating disk |
| 28 | 15 | 1 | 5322 532 50824 | Insulating bush |
| 29 | 15 | 1 | 5322 466 90433 | Mica washer |
| 30 | 15 | 2 | 5322 255 40072 | Bush |
| 31 | 16 | 2 | 5322 255 44107 | IC-holder |
| 32 | 16 | 5 | 5322 255 40064 | Transistor base |
| 33 | 15 | 1 | 5322 255 44064 | Heat sink |
| 34 | 15 | 18 | 5322 255 44108 | Transistor spacer |
| 35 | 15 | 1 | 5322 255 44047 | IC-holder |
| 36 | 15 | 1 | 5322 265 54006 | Female connector, 16-pole |
| 37 | 15 | 2 | 5322 255 44069 | Washer |
| 38 | 15 | 4 | 5322 325 30009 | Ceramic tube |
| 39 | 15 | 1 | 5322 276 14285 | Push-button switch |
| 40 | 15 | 2 | 5322 276 14222 | Push-button switch |
| 41 | 15 | 8 | 5322 276 14276 | Push-button switch |
| 42 | 15 | 1 | 4822 276 10559 | Guide part |
| 43 | 16 | 2 | 4822 255 40115 | Mounting set |
| 44 | 13 | 1 | 5322 459 24067 | Window |
| 45 | 17 | 4 | 5322 255 44073 | IC-holder |
| 46 | 15 | 1 | 5322 267 64007 | Housing for 16 pin contacts |
| 47 | 15 | 16 | 5322 268 14013 | Pin contact |

Fig. 13. Front view, mechanical components

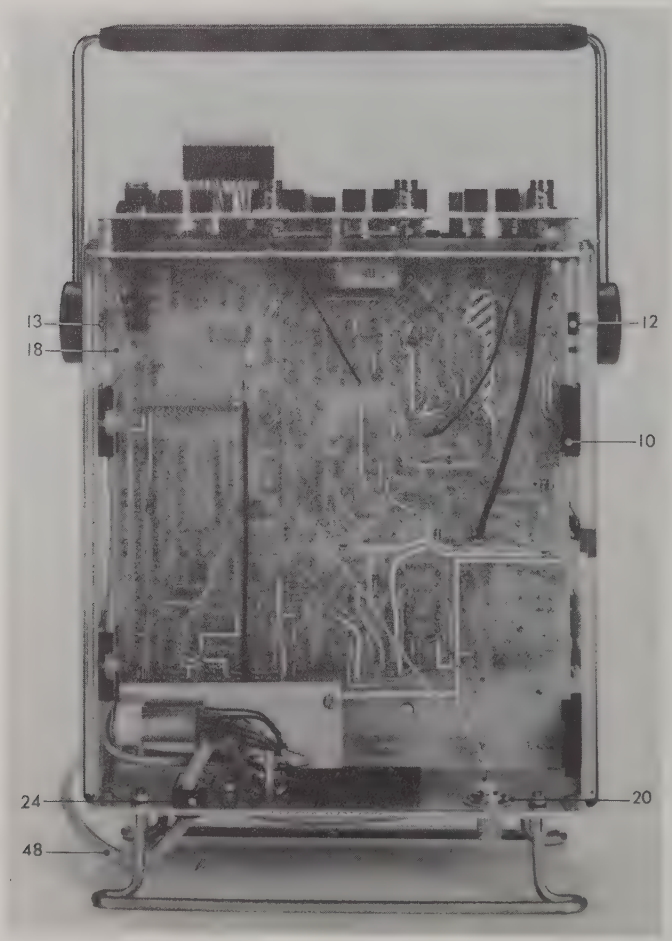



Fig. 14. Bottom view, mechanical components

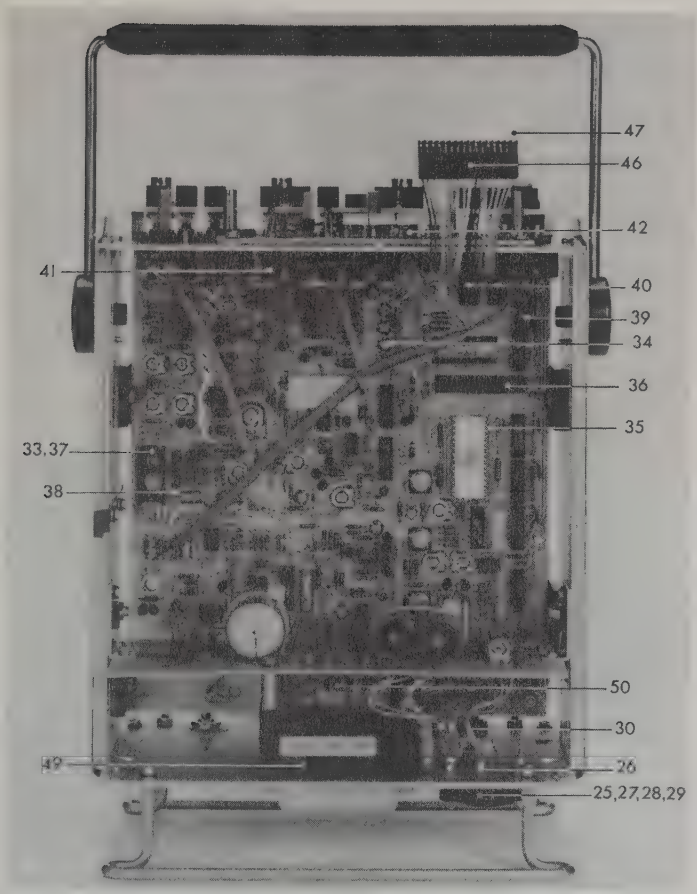



Fig. 15. Top view, mechanical components

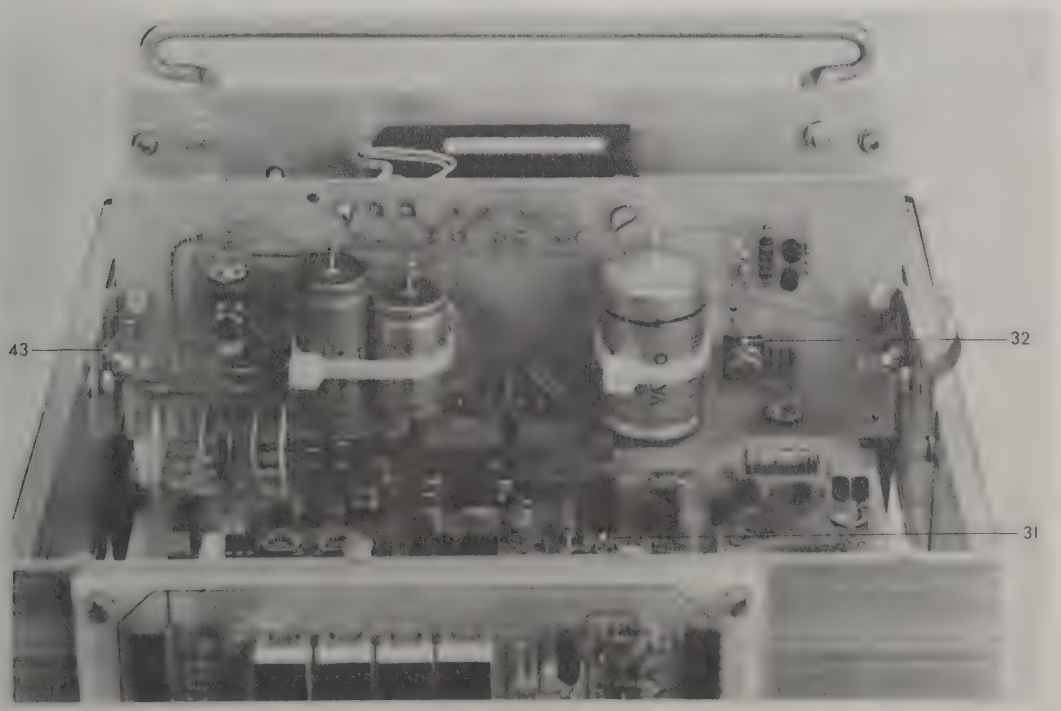



Fig. 16. Inside view on unit 2, mechanical components

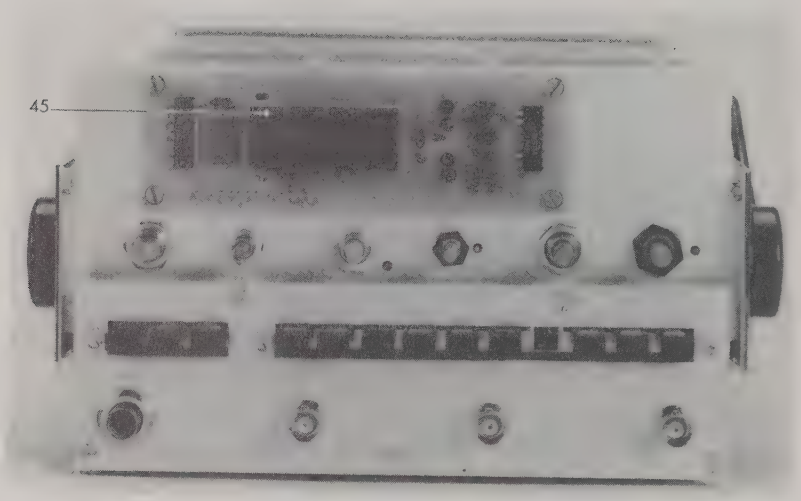



Fig. 17. Front view with textplate removed, mechanical components

## 4.5.2. ELECTRICAL PARTS

**Not on units**

INTEGRATED CIRCUITS

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| 423 | 5322 209 84247 | SG309K |

CAPACITORS

| ITEM | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS |
|---|---|---|---|---|---|
| 510 | 4822 121 40176 | 1,0MU | 10 | 100 | POLYESTER FOIL |
| 530 | 4822 122 30027 | 1N | 10 | 63 | CERAMIC PLATE |
| 571 | 5322 121 44115 | 2X2,5N | 20 | 250 | POLYESTER FOIL |

RESISTORS

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| 610 | 4822 110 53161 | 100K | 5 | CR37 | CARBON |
| 619 | 5322 103 64034 | 10K | 5 LIN | 1W | WIRE-WOUND POTENTIOMETER |
| 620 | 5322 116 54549 | 1,0K | 1 | MR25 | METAL FILM |
| 626 | 5322 101 24096 | 1,0K | 5 LIN | 0,15W | CARBON POTM LIN |
| 701 | 5322 101 34021 | 4,7M | 10 +LOG | 0,2W | CARBON POTM LOG |
| 721 | 4822 101 20295 | 470 | 20 LIN | 0,25W | CARBON POTM LIN |
| 725 | 4822 101 20416 | 4,7K | 20 LIN | 0,1W | CARBON POTM LIN |
| 776 | 4822 101 20297 | 2,2K | 20 LIN | 0,25W | CARBON POTM LIN |

UNIT 1

TRANSISTORS

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| 301,302 | 5322 130 44197 | BC558B |
| 303 | 5322 130 44256 | BC557 |
| 304 | 5322 130 44197 | BC558B |
| 305 | 5322 130 44256 | BC557 |
| 306 | 5322 130 44197 | BC558B |
| 307 | 5322 130 44453 | BCY59X |
| 309,311 | 5322 130 44197 | BC558B |
| 312 | 5322 130 44452 | BFQ11 |
| 313 | 5322 130 44197 | BC558B |
| 314 | 4822 130 40937 | BC548B |
| 315 | 5322 130 44197 | BC558B |
| 316 | 5322 130 40408 | BFW11 |
| 317 | 5322 130 44453 | BCY59X |
| 318 | 4822 130 40937 | BC548B |
| 319 | 5322 130 44197 | BC558B |
| 321 | 5322 130 44594 | 2N3964 |
| 322 | 5322 130 44285 | BCY58X |
| 323 | 5322 130 44594 | 2N3964 |
| 324 | 5322 130 44285 | BCY58X |
| 325 | 5322 130 40408 | BFW11 |
| 326 | 4822 130 40959 | BC547B |
| 327 | 5322 130 44256 | BC557 |
| 328 | 4822 130 40937 | BC548B |
| 329 | 4822 130 40959 | BC547B |
| 331 | 5322 130 44442 | ON634 SEL,PAIR |
| 332 | 5322 130 44256 | BC557 |
| 333,334 | 5322 130 44197 | BC558B |
| 335,336 | 4822 130 40937 | BC548B |
| 337,338 | 5322 130 44197 | BC558B |
| 339 | 4822 130 40937 | BC548B |

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| 341 | 5322 130 44197 | BC558B |
| 342,343 | 4822 130 40937 | BC548B |
| 344 | 5322 130 44197 | BC558B |
| 346 | 5322 130 44509 | BFQ16 |
| 347,348 | 4822 130 40937 | BC548B |
| 349 | 5322 130 44442 | ON634 SEL PAIR |
| 351 | 5322 130 44197 | BC558B |
| 352 | 5322 130 34044 | BSV80 |
| 354 | 5322 130 44121 | BC338 |
| 355 | 4822 130 40937 | BC548B |
| 356 | 5322 130 34044 | BSV80 |
| 357 | 5322 130 44256 | BC557 |
| 358 | 4822 130 40959 | BC547B |
| 359 | 5322 130 44256 | BC557 |
| 361 | 5322 130 44121 | BC338 |
| 362 | 5322 130 44256 | BC557 |
| 363 | 5322 130 40823 | BD139 |
| 364-368 | 5322 130 44017 | BSV79 |
| 369 | 4822 130 40937 | BC548B |
| 370 | 5322 130 44017 | BSV79 |
| 371 | 5322 130 44452 | BFQ11 |
| 372 | 4822 130 40937 | BC548B |
| 373 | 5322 130 44231 | BFW12 |
| 374 | 4822 130 40937 | BC548B |
| 376,377 | 5322 130 44197 | BC558B |
| 378 | 5322 130 44452 | BFQ11 |
| 380 | 5322 130 40408 | BFW11 |
| 381-384 | 5322 130 44197 | BC558B |
| **INTEGRATED CIRCUITS** | | |
| 401,402 | 5322 209 85254 | MUA 741 CV |
| 403 | 5322 209 85462 | MC 1458 C – P1 |
| 404 | 5322 209 85461 | CA3183E |
| 405,406 | 5322 209 85254 | MUA 741 CV |
| 407 | 5322 209 84528 | SN7400N-00 |
| 408 | 5322 209 84073 | SN7406N-00 |
| 409 | 5322 209 84778 | OC011 |
| 410,411 | 5322 209 84091 | TDA222 |
| 412 | 5322 209 85254 | MUA 741 CV |
| 413 | 5322 209 84091 | TBA222 |
| 415 | 5322 209 14026 | HEF 4739 VP |
| 416 | 5322 209 84529 | SN7403N-S1 |
| 417,418 | 5322 209 84528 | SN7400N-00 |
| 419 | 5322 209 80148 | SN7404N-00 |
| 420 | 5322 209 85332 | SN7433N-00 |
| **DIODES** | | |
| 431 | 5322 130 34397 | BZX92 |
| 432,433 | 5322 130 30759 | BZX79-C5V6 |
| 434 | 5322 130 34321 | 1N4151 |
| 435 | 5322 130 34281 | BZX79-C15 |
| 436 | 5322 130 34049 | BZX75-C2V1 |
| 437 | 5322 130 34048 | BZX75-C2V8 |
| 438 | 5322 130 34047 | BZX75-C1V4 |
| 439 | 5322 130 34281 | BZX79-B15 |
| 440-442 | 5322 130 34321 | 1N4151 |
| 443 | 5322 130 34382 | BZX79-B8V2 |
| 444 | 5322 130 34397 | BZX92 |
| 445 | 5322 130 34281 | BZX79-C15 |
| 446 | 5322 130 34281 | BZX79-B15 |
| 447 | 5322 130 30766 | BZX79-C6V2 |
| 448 | 5322 130 34397 | BZX93 |

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| 449 | 5322 130 30686 | 1N4446 |
| 450 | 5322 130 34049 | BZX75-C2V1 |
| 451 | 5322 130 34397 | BZX90 |
| 452 | 5322 130 34281 | BZX79-C15 |
| 453 | 5322 130 30686 | 1N4446 |
| 454 | 5322 130 30771 | BZX79-C13 |
| 455,456 | 4822 130 30862 | BZX79-B9V1 |
| 457-460 | 5322 130 34321 | 1N4151 |
| 461 | 5322 130 34047 | BZX75-C1V4 |
| 462 | 5322 130 30759 | BZX79-C5V6 |
| 463 | 5322 130 30667 | BZX79-C9V1 |
| 464 | 5322 130 34281 | BZX79-C15 |
| 465 | 5322 130 34397 | BZX93 |
| 495,496 | 5322 130 34049 | BZX75-C2V1 |

CAPACITORS

| ITEM | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS |
|---|---|---|---|---|---|
| 501 | 4822 124 20475 | 10MU | | 25 | ELECTROLYTIC |
| 502 | 4822 124 20463 | 100MU | | 10 | ELECTROLYTIC |
| 503 | 4822 124 20476 | 22MU | | 25 | ELECTROLYTIC |
| 504 | 4822 124 20463 | 100MU | | 10 | ELECTROLYTIC |
| 505 | 4822 122 31058 | 15P | 2 | 100 | CERAMIC PLATE |
| 506 | 5322 121 40197 | 1MU | 10 | 100 | POLYESTER FOIL |
| 507 | 4822 122 31058 | 15P | 2 | 100 | CERAMIC PLATE |
| 508 | 5322 121 50338 | 470N | 1 | 63 | POLYSTYRENE FOIL |
| 509 | 4822 121 50539 | 4,7N | 1 | 63 | POLYSTYRENE FOIL |
| 511 | 5322 121 54129 | 430P | 5 | 250 | POLYSTYRENE FOIL |
| 512 | 4822 125 50017 | 5,5-65P | | 100 | TRIMMER |
| 513-515 | 4822 122 30043 | 10N | -20+80 | 63 | CERAMIC PLATE |
| 516 | 4822 122 31072 | 47P | 2 | 100 | CERAMIC PLATE |
| 517 | 4822 122 31172 | 180P | 2 | 100 | CERAMIC PLATE |
| 518 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 519 | 4822 122 31069 | 39P | 2 | 100 | CERAMIC PLATE |
| 520 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 521 | 4822 122 31074 | 56P | 2 | 100 | CERAMIC PLATE |
| 522 | 4822 122 31125 | 4,7N | -20+80 | 63 | CERAMIC PLATE |
| 523 | 4822 121 40252 | 6,8MU | 10 | 100 | POLYESTER FOIL |
| 524,525 | 4822 122 30128 | 4,7N | 10 | 100 | CERAMIC PLATE |
| 526 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 527 | 5322 121 40323 | 100N | 20 | 100 | POLYESTER FOIL |
| 528 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 529 | 4822 122 31061 | 18P | 2 | 100 | CERAMIC PLATE |
| 531 | 4822 124 20475 | 10MU | | 25 | ELECTROLYTIC |
| 533 | 4822 122 31072 | 47P | 2 | 100 | CERAMIC PLATE |
| 534 | 4822 124 20496 | 10MU | | 40 | ELECTROLYTIC |
| 535, 536 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 539 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |
| 540 | 4822 122 30043 | 10N | -20+80 | 63 | CERAMIC PLATE |
| 541 | 4822 121 50566 | 1,0N | 5 | 125 | POLYSTYRENE FOIL |
| 542 | 4822 122 31177 | 470P | 10 | 100 | CERAMIC PLATE |
| 544 | 4822 125 50017 | 5,5-65P | | | TRIMMER |
| 545-551 | 4822 122 30103 | 22N | -20+80 | 63 | CERAMIC PLATE |

RESISTORS

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| 601 | 4822 110 63105 | 820 | 5 | CR25 | CARBON |
| 602 | 5322 116 54787 | 2,61K | 1 | MR24E | METAL FILM |
| 603 | 5322 100 10113 | 10K | 20 LIN | 0,5W | TRIMMING POTM |
| 604 | 5322 116 50608 | 6,19K | 1 | MR25 | METAL FILM |
| 605 | 5322 116 54613 | 8,66K | 1 | MR25 | METAL FILM |
| 606 | 5322 116 54561 | 1,33K | 1 | MR25 | METAL FILM |
| 607 | 4822 110 63125 | 4,7K | 5 | CR25 | CARBON |
| 608 | 5322 116 50556 | 4,42K | 1 | MR25 | METAL FILM |
| 609 | 4822 110 60157 | 75K | 5 | CR25 | CARBON |
| 611 | 5322 116 50514 | 64,9K | 1 | MR24E | METAL FILM |
| 612 | 5322 110 60173 | 300K | 5 | CR25 | CARBON |
| 613 | 5322 100 10114 | 5,0K | 20 LIN | 0,5W | TRIMMING POTM |
| 614 | 5322 116 54585 | 3,48K | 1 | MR24 | METAL FILM |
| 615 | 5322 116 54187 | 1,47K | 1 | MR24E | METAL FILM |
| 616 | 5322 116 54994 | 162 | 1 | MR24E | METAL FILM |
| 617 | 5322 116 54619 | 10K | 1 | MR24 | METAL FILM |
| 618 | 4822 110 60137 | 13K | 5 | CR25 | CARBON |
| 623 | 5322 116 54492 | 178 | 1 | MR24 | Metal film |
| 624 | 5322 116 54497 | 2,26K | 1 | MR25 | Metal film |
| 625 | 5322 111 44193 | 3,0 | 5 | CR25 | CARBON |
| | 4822 110 63041 | 3,3 | 5 | CR25 | CARBON |
| | 5322 111 44194 | 3,6 | 5 | CR25 | CARBON |
| | 4822 110 63043 | 3,9 | 5 | CR25 | CARBON |
| | 5322 111 44164 | 4,3 | 5 | CR25 | CARBON |
| | 4822 110 63045 | 4,7 | 5 | CR25 | CARBON |
| | 5322 116 54192 | 5,1 | 5 | CR25 | METAL FILM |
| 627 | 5322 116 50483 | 38,3K | 1 | MR25 | METAL FILM |
| 628 | 5322 116 50536 | 464 | 1 | MR25 | METAL FILM |
| 629 | 5322 116 54497 | 226 | 1 | MR25 | METAL FILM |
| 630 | | | | MR25 | Adjustment |
| 631 | 4822 110 60113 | 1,6K | 5 | CR25 | CARBON |
| 632 | 4822 110 60137 | 13K | 5 | CR25 | CARBON |
| 633 | 5322 116 54497 | 226 | 1 | MR25 | METAL FILM |
| 634 | 5322 116 54595 | 5,11 K | 1 | MR25 | METAL FILM |
| 635 | 5322 116 50664 | 2,05K | 1 | MR25 | METAL FILM |
| 636 | 5322 116 50592 | 442 | 1 | MR25 | METAL FILM |
| 637 | 5322 116 54595 | 5,11 K | 1 | MR25 | METAL FILM |
| 638 | 5322 116 50664 | 2,05K | 1 | MR25 | METAL FILM |
| 639 | 5322 116 50592 | 442 | 1 | MR25 | METAL FILM |
| 641 | 5322 116 54595 | 5,11 K | 1 | MR25 | METAL FILM |
| 642 | 5322 116 54587 | 3,65K | 1 | MR25 | METAL FILM |
| 643 | 5322 116 54589 | 3,83K | 1 | MR25 | METAL FILM |
| 644 | 5322 116 50729 | 4,22K | 1 | MR25 | METAL FILM |
| 645 | 5322 116 55129 | 274 | 1 | MR30 | METAL FILM |
| 646 | 5322 116 54835 | 510 | 5 | CR52 | METAL FILM |
| 647 | 5322 116 50481 | 22,6K | 1 | MR25 | METAL FILM |
| 648 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 649 | 5322 116 50481 | 22,6K | 1 | MR25 | METAL FILM |
| 651 | 5322 116 54541 | 825 | 1 | MR25 | METAL FILM |
| 652 | 5322 116 54585 | 3,48K | 1 | MR25 | METAL FILM |
| 653 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 654 | 5322 101 14009 | 220 | 20 LIN | 0,5W | TRIMMING POTM |
| 655 | 5322 116 50536 | 464 | 1 | MR25 | METAL FILM |
| 656 | 5322 116 50636 | 2,74K | 1 | MR25 | METAL FILM |
| 657 | 5322 116 50671 | 2,61K | 1 | MR25 | METAL FILM |
| 658,659 | 5322 116 50728 | 1,87K | 1 | MR25 | METAL FILM |
| 661 | 5322 116 50671 | 2,61K | 1 | MR25 | METAL FILM |
| 662,663 | 5322 121 40323 | 150 | 5 | CR25 | POLYESTER FOIL |
| 664 | 5322 116 50671 | 2,61K | 1 | MR25 | METAL FILM |
| 665,666 | 5322 116 50767 | 2,15K | 1 | MR25 | METAL FILM |
| 667 | 5322 116 50671 | 2,61K | 1 | MR25 | METAL FILM |
| 668 | 5322 116 50556 | 4,42K | 1 | MR25 | METAL FILM |
| 669 | 4822 110 63141 | 18K | 5 | CR25 | CARBON |
| 670 | 5322 116 54469 | 100 | 1 | MR25 | METAL FILM |

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| 671 | 4822 110 63136 | 12K | 5 | CR25 | CARBON |
| 672 | 5322 116 54624 | 11,5K | 1 | MR25 | METAL FILM |
| 673 | 5322 116 50561 | 590 | 1 | MR25 | METAL FILM |
| 674 | 5322 116 50415 | 1,15K | 1 | MR25 | METAL FILM |
| 675 | 5322 116 50557 | 46,4K | 1 | MR25 | METAL FILM |
| 676 | 5322 116 54525 | 511 | 1 | MR24 | METAL FILM |
| 677 | 5322 116 50592 | 442 | 1 | MR24 | METAL FILM |
| 678 | 5322 116 54525 | 511 | 1 | MR25 | METAL FILM |
| 679 | 5322 116 54619 | 10K | 1 | MR25 | METAL FILM |
| 681 | 5322 116 54525 | 511 | 1 | MR25 | METAL FILM |
| 682 | 5322 116 54603 | 267 | 1 | MR24 | METAL FILM |
| 683 | 5322 116 54482 | 133 | 1 | MR24 | METAL FILM |
| 684 | 5322 116 54469 | 100 | 1 | MR24 | METAL FILM |
| 685 | 5322 116 54608 | 7,5K | 1 | MR25 | METAL FILM |
| 686 | 4822 110 60108 | 1,1K | 5 | CR25 | CARBON |
| 687 | 5322 116 54882 | 715 | 0,25 | MR24E | METAL FILM |
| 688 | 5322 116 54536 | 750 | 1 | MR25 | METAL FILM |
| 689 | 5322 101 10058 | 10K | 20 LIN | 0,2W | TRIMMING POTM |
| 691 | 5322 116 54882 | 715 | 0,25 | MR24E | METAL FILM |
| 692 | 5322 116 50524 | 3,01K | 1 | MR25 | METAL FILM |
| 693,694 | 5322 116 54572 | 2,0K | 5 | CR25 | CARBON |
| 695 | 5322 116 50571 | 715 | 1 | MR25 | METAL FILM |
| 696 | 4822 100 10075 | 100 | 20 LIN | 0,1W | TRIMMING POTM |
| 697 | 5322 116 50571 | 715 | 1 | MR25 | METAL FILM |
| 698 | 5322 116 54536 | 750 | 1 | MR25 | METAL FILM |
| 699 | 4822 110 63138 | 15K | 5 | CR25 | CARBON |
| 702 | 5322 116 54665 | 40,2K | 1 | MR25 | METAL FILM |
| 703 | 5322 116 54689 | 82,5K | 1 | MR25 | METAL FILM |
| 704 | 5322 116 50451 | 21,5K | 1 | MR25 | METAL FILM |
| 705 | 5322 116 54657 | 31,6K | 1 | MR25 | METAL FILM |
| 706 | 4822 100 10036 | 4,7K | 20 LIN | 0,1W | TRIMMING POTM |
| 707 | 5322 116 50731 | 10,5K | 1 | MR25 | METAL FILM |
| 708 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 709 | 5322 116 54689 | 82,5K | 1 | MR25 | METAL FILM |
| 711 | 5322 116 54613 | 8,66K | 1 | MR25 | METAL FILM |
| 712 | 5322 116 54648 | 24,9K | 1 | MR25 | METAL FILM |
| 713 | 5322 116 54592 | 4,02K | 1 | MR25 | METAL FILM |
| 714 | 5322 116 54005 | 3,32K | 1 | MR25 | METAL FILM |
| 715 | 5322 116 54008 | 4,75K | 1 | MR25 | METAL FILM |
| 716 | 5322 116 50479 | 15,4K | 1 | MR25 | METAL FILM |
| 717 | 5322 116 54005 | 3,32K | 1 | MR25 | METAL FILM |
| 723 | 5322 116 54536 | 750 | 1 | MR25 | METAL FILM |
| 726 | 5322 116 54549 | 1,0K | 1 | MR25 | METAL FILM |
| 727 | 5322 116 54499 | 249 | 1 | MR25 | METAL FILM |
| 728 | 5322 116 54562 | 1,4K | 1 | MR25 | METAL FILM |
| 729 | 5322 116 54637 | 17,8K | 1 | MR25 | METAL FILM |
| 731 | 5322 116 54678 | 59K | 1 | MR25 | METAL FILM |
| 733 | 5322 116 54732 | 237K | 1 | MR25 | METAL FILM |
| 734 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 735 | 5322 116 50459 | 422 | 1 | MR25 | METAL FILM |
| 736 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 737 | 5322 116 54541 | 825 | 1 | MR25 | METAL FILM |
| 738 | 5322 116 50523 | 4,99K | 1 | MR25 | METAL FILM |
| 739 | 5322 116 54442 | 51,1 | 1 | MR25 | METAL FILM |
| 741 | 5322 116 54595 | 5,11K | 1 | MR25 | METAL FILM |
| 742 | 4822 100 10035 | 10K | 20 LIN | 0,1W | TRIMMING POTM |
| 743 | 4822 110 63101 | 560 | 5 | CR25 | CARBON |
| 744 | 4822 110 63161 | 100K | 5 | CR25 | CARBON |
| 745,746 | 4822 110 63125 | 4,7K | 5 | CR25 | CARBON |
| 747 | 4822 110 63147 | 33K | 5 | CR25 | CARBON |
| 748 | 4822 110 60115 | 2,0K | 5 | CR25 | CARBON |
| 749 | 4822 110 63094 | 330 | 5 | CR25 | CARBON |
| 751 | 4822 110 60142 | 20K | 5 | CR25 | CARBON |
| 752 | 4822 110 63138 | 15K | 5 | CR25 | CARBON |

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| 753 | 4822 110 60168 | 200K | 5 | CR25 | CARBON |
| 755 | 4822 110 63074 | 56 | 5 | CR25 | CARBON |
| 756 | 5322 116 54613 | 8,66K | 1 | MR25 | METAL FILM |
| 757 | 4822 100 10038 | 470 | 20 LIN | 0,1W | TRIMMING POTM |
| 758 | 5322 116 54636 | 17,4K | 1 | MR25 | METAL FILM |
| 759 | 4822 110 63169 | 220K | 5 | CR25 | CARBON |
| 761 | 4822 110 63098 | 470 | 5 | CR25 | CARBON |
| 762 | 4822 110 63114 | 1,8K | 5 | CR25 | CARBON |
| 763 | 4822 100 10038 | 470 | 20 LIN | 0,1W | TRIMMING POTM |
| 764 | 5322 116 54615 | 9,09K | 1 | MR25 | METAL FILM |
| 765 | 4822 100 10036 | 4,7K | 20 LIN | 0,1W | TRIMMING POTM |
| 767 | 5322 116 50635 | 1,47K | 1 | MR25 | METAL FILM |
| 768 | 4822 110 63125 | 4,7K | 5 | CR25 | CARBON |
| 769 | 4822 110 63138 | 15K | 5 | CR25 | CARBON |
| 771 | 4822 100 10019 | 220 | 20 LIN | 0,1W | TRIMMING POTM |
| 772 | 4822 110 63058 | 15 | 5 | CR25 | CARBON |
| 773 | 4822 110 60119 | 3,0K | 5 | CR25 | CARBON |
| 775 | 5322 116 50675 | 2,26K | 1 | MR25 | METAL FILM |
| 777 | 5322 116 50904 | 30,1 | 1 | MR25 | METAL FILM |
| 778 | 4822 110 60119 | 3,0K | 5 | CR25 | CARBON |
| 779 | 5322 116 54632 | 14,7K | 1 | MR25 | METAL FILM |
| 780 | 5322 116 54469 | 100 | 1 | MR25 | METAL FILM |
| 781 | 5322 116 54508 | 301 | 1 | MR25 | METAL FILM |
| 782 | 5322 116 54643 | 20,5K | 1 | MR25 | METAL FILM |
| 783 | 5322 101 14048 | 47K | 20 LIN | 0,5W | TRIMMING POTM |
| 784 | 5322 116 54479 | 127 | 1 | MR25 | METAL FILM |
| 785 | 5322 116 55135 | 120 | 5 | PR52 | METAL FILM |
| 786 | 5322 116 54557 | 1,21K | 1 | MR25 | METAL FILM |
| 787 | 5322 116 50414 | 2,87K | 1 | MR25 | METAL FILM |
| 788 | 5322 116 50484 | 4,64K | 1 | MR25 | METAL FILM |
| 789 | 5322 116 54441 | 49,9 | 1 | MR25 | METAL FILM |
| 790 | 4822 110 63209 | 6,8M | 10 | CR25 | CARBON |
| 791 | 5322 116 50559 | 27,4K | 1 | MR25 | METAL FILM |
| 792 | 5322 116 54655 | 30,1K | 1 | MR25 | METAL FILM |
| 793 | 4822 110 60157 | 75K | 5 | CR25 | CARBON |
| 794 | 5322 116 50757 | 51,1 | 0,1 | MR24E | METAL FILM |
| 795 | 5322 116 54232 | 1,27K | 0,1 | MR24E | METAL FILM |
| 796 | 5322 116 55131 | 442 | 0,1 | MR24E | METAL FILM |
| 797 | 4822 110 60157 | 75K | 5 | CR25 | CARBON |
| 798 | 5322 116 54186 | 4,42K | 0,1 | MR24E | METAL FILM |
| 799 | 4822 110 60157 | 75K | 5 | CR25 | CARBON |
| 800 | 4822 100 10036 | 4,7K | 20 LIN | 0,1W | TRIMMING POTM |
| 801 | 5322 116 55132 | 44,2K | 0,1 | MR24E | METAL FILM |
| 802 | 4822 110 60157 | 75K | 5 | CR25 | CARBON |
| 803 | 5322 116 54665 | 40,2K | 1 | MR25 | METAL FILM |
| 804 | 4822 110 60137 | 13K | 5 | CR25 | CARBON |
| 805 | 4822 110 63141 | 18K | 5 | CR25 | CARBON |
| 806 | 5322 116 54665 | 40,2K | 1 | MR25 | METAL FILM |
| 807 | 5322 116 54651 | 26,1K | 1 | MR25 | METAL FILM |
| 808 | 5322 116 54637 | 17,8K | 1 | MR25 | METAL FILM |
| 809,810 | 5322 116 54608 | 7,5K | 1 | MR25 | METAL FILM |
| 811,812 | 5322 116 50748 | 10K | 1 | MR24E | METAL FILM |
| 813 | 5322 116 54191 | 30,1K | 1 | MR24E | METAL FILM |
| 814,815 | 5322 116 55133 | 60,4K | 0,1 | MR24E | METAL FILM |
| 816 | 5322 116 50555 | 1,27K | 1 | MR25 | METAL FILM |
| 817 | 5322 116 50556 | 4,42K | 1 | MR25 | METAL FILM |
| 818,819 | 5322 116 54285 | 19,6K | 0,1 | MR24E | METAL FILM |
| 820 | 5322 116 54641 | 19,6K | 1 | MR25 | METAL FILM |
| 821 | 4822 100 10036 | 4,7K | 20 LIN | 0,1W | TRIMMING POTM |
| 822 | 4822 110 60124 | 4,3K | 5 | CR25 | CARBON |
| 823 | 4822 100 10036 | 4,7K | 20 LIN | 0,1W | TRIMMING POTM |
| 824 | 5322 116 50581 | 2,49K | 1 | MR25 | METAL FILM |
| 825 | 5322 116 50559 | 27,4K | 1 | MR25 | METAL FILM |
| 826 | 5322 116 55036 | 12,1K | 1 | MR24E | METAL FILM |
| 827 | 4822 100 10037 | 1,0K | 20 LIN | 0,1W | TRIMMING POTM |

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| 829 | 5322 116 55036 | 12,1K | 1 | MR24E | METAL FILM |
| 831 | 5322 116 54529 | 619 | 1 | MR25 | METAL FILM |
| 833 | 5322 116 54683 | 68,1K | 1 | MR25 | METAL FILM |
| 835 | 5322 116 55144 | 174K | 1 | MR34E | METAL FILM |
| 836 | 5322 116 54292 | 1,69K | 1 | MR24E | METAL FILM |
| 837 | 5322 116 55033 | 1,05K | 1 | MR24E | METAL FILM |
| 838 | 5322 116 54227 | 100K | 1 | MR34E | METAL FILM |
| 839 | 5322 116 54543 | 866 | 1 | MR25 | METAL FILM |
| 842 | 4822 110 63125 | 4,7K | 5 | CR25 | CARBON |
| 845 | 4822 110 60128 | 6,2K | 5 | CR25 | CARBON |
| 846 | 4822 110 63149 | 39K | 5 | CR25 | CARBON |
| 847 | 4822 110 63105 | 820 | 5 | CR25 | CARBON |
| 848 | 4822 110 60128 | 6,2K | 5 | CR25 | CARBON |
| 849 | 4822 110 63149 | 39K | 5 | CR25 | CARBON |
| 851 | 4822 110 63105 | 820 | 5 | CR25 | CARBON |
| 852 | 4822 110 60128 | 6,2K | 5 | CR25 | CARBON |
| 853 | 4822 110 63149 | 39K | 5 | CR25 | CARBON |
| 854 | 4822 110 63105 | 820 | 5 | CR25 | CARBON |
| 855 | 4822 110 60128 | 6,2K | 5 | CR25 | CARBON |
| 856 | 4822 110 63149 | 39K | 5 | CR25 | CARBON |
| 857 | 4822 110 63105 | 820 | 5 | CR25 | CARBON |

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| **COILS** | | |
| 754 | 5322 158 10276 | 4,7MUH |
| 766 | 5322 158 14034 | 220MUH |
| 841 | 5322 158 10276 | 4,7MUH |
| **UNIT 2** | | |
| **TRANSISTORS** | | |
| 391 | 4822 130 40982 | BD437 |
| 392 | 4822 130 40937 | BC548B |
| 393 | 5322 130 44197 | BC558B |
| 394 | 5322 130 40823 | BD139 |
| **INTEGRATED CIRCUITS** | | |
| 424,425 | 5322 209 84899 | MUA723CV |
| **DIODES** | | |
| 471 | 5322 130 34167 | BZX79-B6V2 |
| 491-493 | 5322 130 30414 | BY164 |

| ITEM | ORDERING NUMBER | FARAD | TOL (%) | VOLTS | REMARKS |
|---|---|---|---|---|---|
| **CAPACITORS** | | | | | |
| 555 | 4822 124 20583 | 1,0MU | | 63 | ELECTROLYTIC |
| 556 | 5322 124 24084 | 2200MU | | 16 | ELECTROLYTIC |
| 557,558 | 4822 124 20583 | 1,0MU | | 63 | ELECTROLYTIC |
| 559 | 4822 122 31168 | 270P | 10 | 100 | CERAMIC PLATE |
| 562 | 5322 124 24182 | 1000MU | | 40 | ELECTROLYTIC |
| 563 | 5322 124 24067 | 1000MU | | 63 | ELECTROLYTIC |

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| **RESISTORS** | | | | | |
| 878 | 5322 113 44157 | 1,6 | 5 | 0,5W | WIRE-WOUND |
| 879 | 5322 112 10035 | 2,0 | 5 | 0,5W | WIRE-WOUND |
| 881 | 4822 110 63092 | 270 | 5 | CR25 | CARBON |
| 882 | 4822 110 60088 | 200 | 5 | CR25 | CARBON |
| 883 | 4822 110 63125 | 4,7K | 5 | CR25 | CARBON |
| 884 | 5322 116 50728 | 1,87K | 1 | MR25 | METAL FILM |
| 885,886 | 5322 116 54576 | 2,37K | 1 | MR25 | METAL FILM |
| 887 | 4822 100 10021 | 1,0K | 20 LIN | 0,1W | TRIMMING POTM |
| 888,889 | 5322 116 54592 | 4,02K | 1 | MR25 | METAL FILM |
| 891 | 4822 100 10021 | 1,0K | 20 LIN | 0,1W | TRIMMING POTM |
| 892 | 5322 116 54605 | 6,98K | 1 | MR25 | METAL FILM |
| 893 | 5322 116 54549 | 1,0K | 1 | MR25 | METAL FILM |

| ITEM | ORDERING NUMBER | TYPE/DESCRIPTION |
|---|---|---|
| **UNIT 3** | | |
| **TRANSISTORS** | | |
| 386 – 389 | 4822 130 40988 | BC328-25 |
| **INTEGRATED CIRCUITS** | | |
| 421 | 5322 209 84035 | SN7416N-00 |
| 422 | 5322 209 84681 | SN7447AN-00 |
| **DIODES** | | |
| 466-469 | 4822 130 30914 | CQY54 |
| 481-484 | 5322 130 34389 | HP5082-7730 |

| ITEM | ORDERING NUMBER | OHM | TOL (%) | TYPE | REMARKS |
|---|---|---|---|---|---|
| **RESISTORS** | | | | | |
| 858 – 861 | 5322 116 50669 | 205 | 1 | MR25 | METAL FILM |
| 862 – 871 | 5322 116 50578 | 78,7 | 1 | MR25 | METAL FILM |
| 872 – 875 | 5322 116 51052 | 42,2 | 1 | MR25 | METAL FILM |
| 876,877 | 5322 116 54508 | 301 | 1 | MR25 | METAL FILM |

### 4.5.3. MISCELLANEOUS

| ITEM | FIG. | QUANTITY | ORDERING NUMBER | DESCRIPTION |
|---|---|---|---|---|
| 48 | 14 | 1 | 5322 321 14048 | Mains cable |
| 49 | 15 | 1 | 5322 146 34075 | Mains transformer |
| 50 | 15 | 1 | 4822 252 20001 | Thermal fuse |

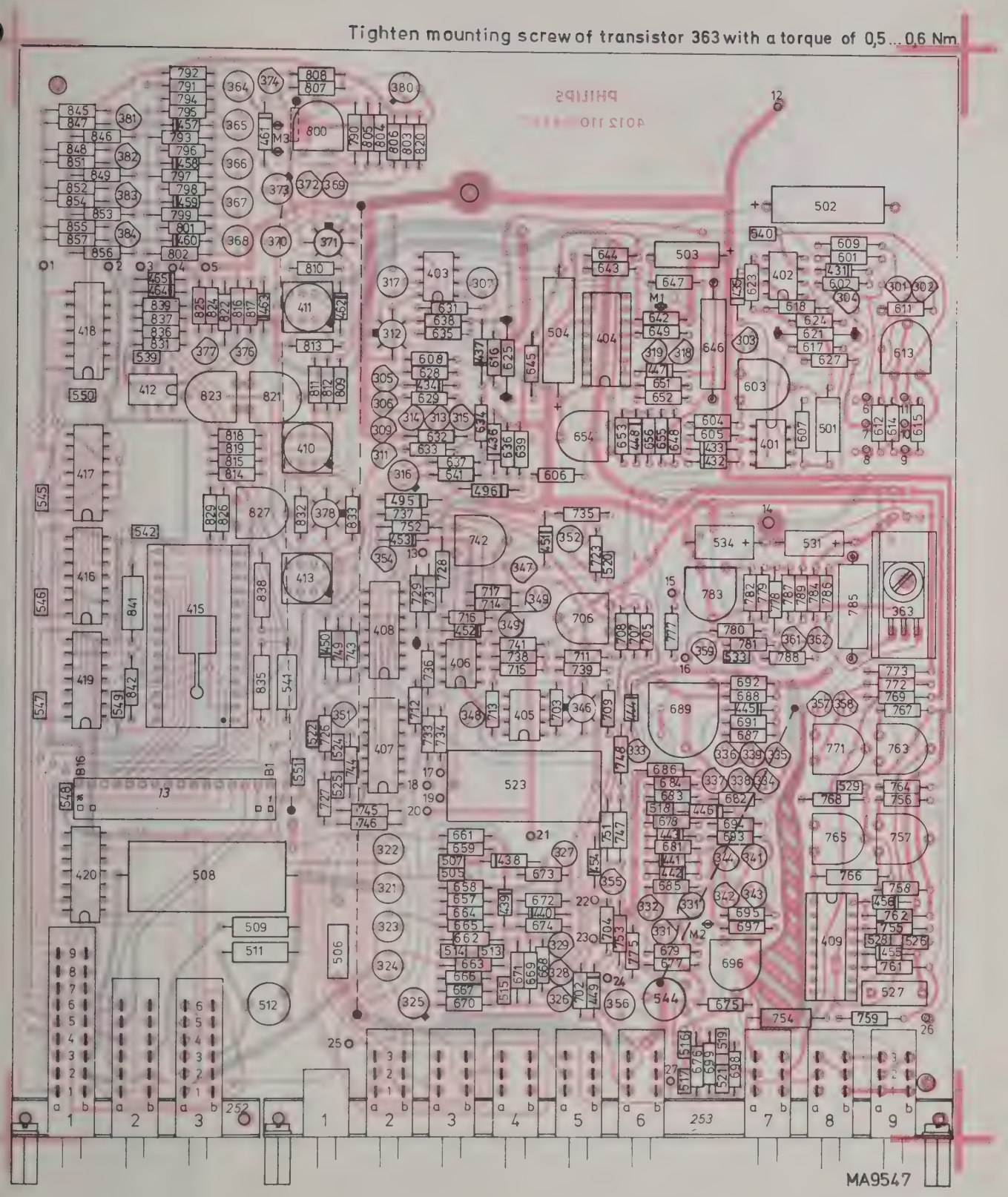



Fig. 18. Printed-wiring board unit 1

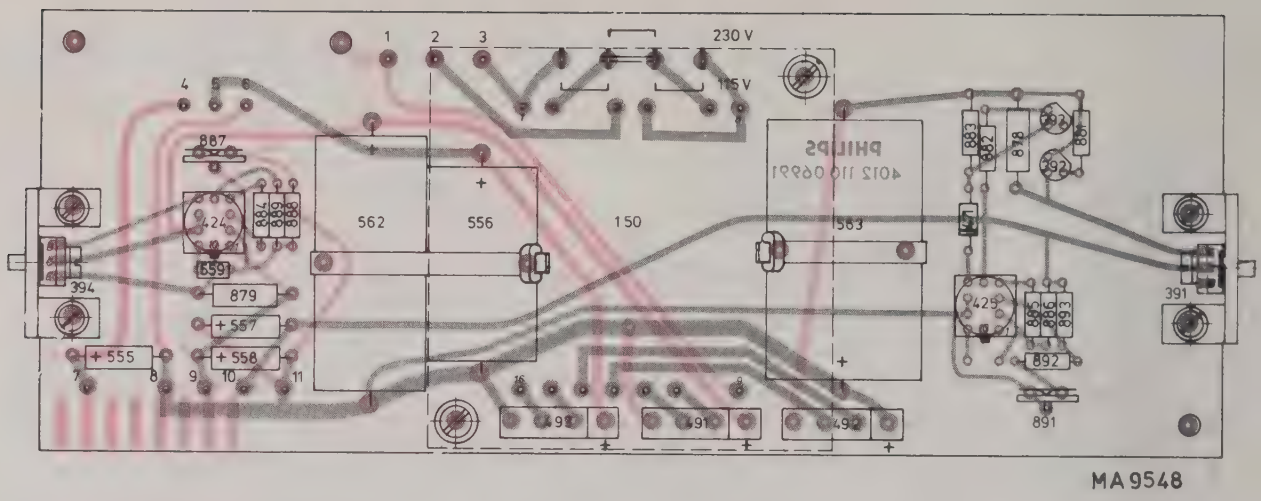



Fig. 19. Printed-wiring board unit 2

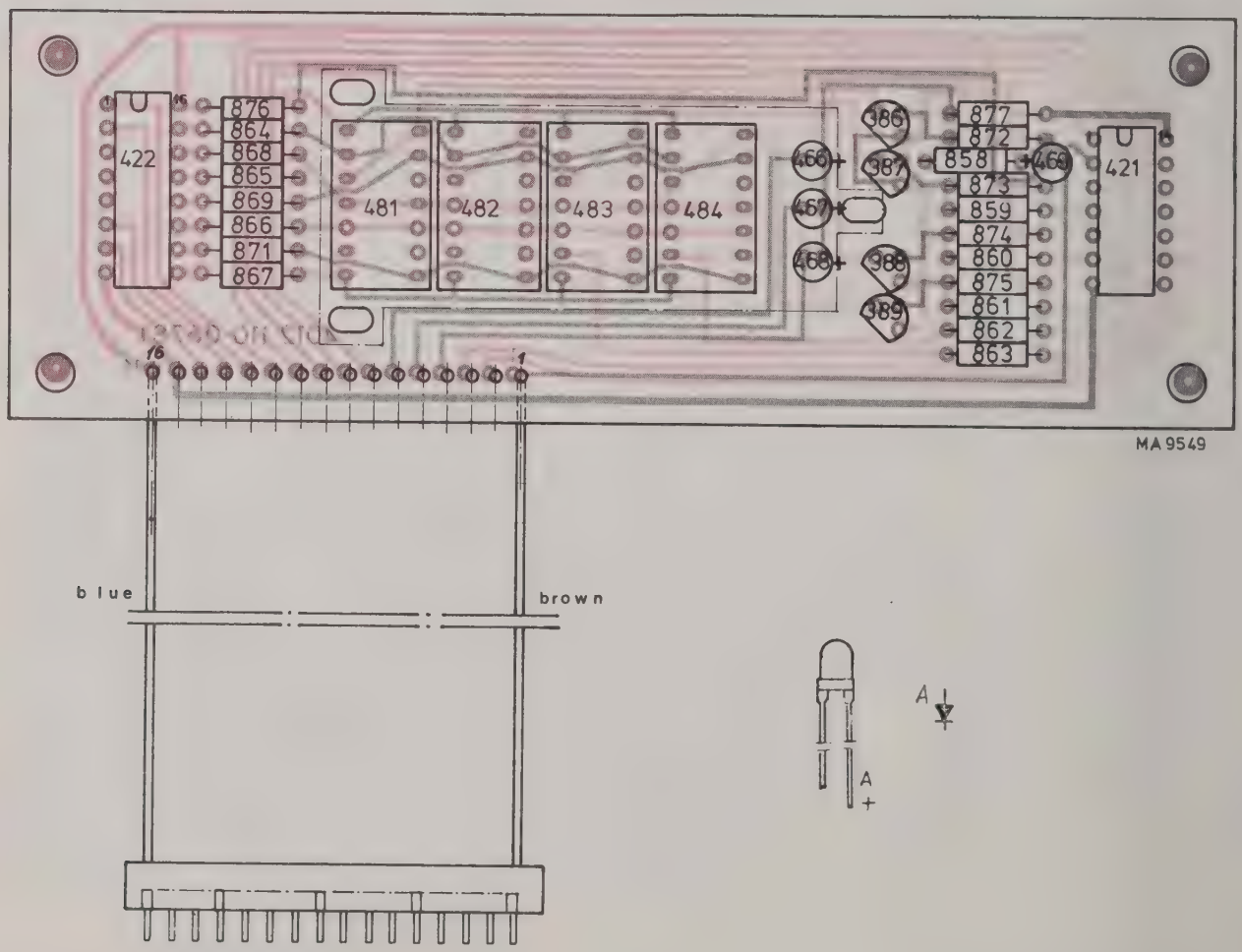
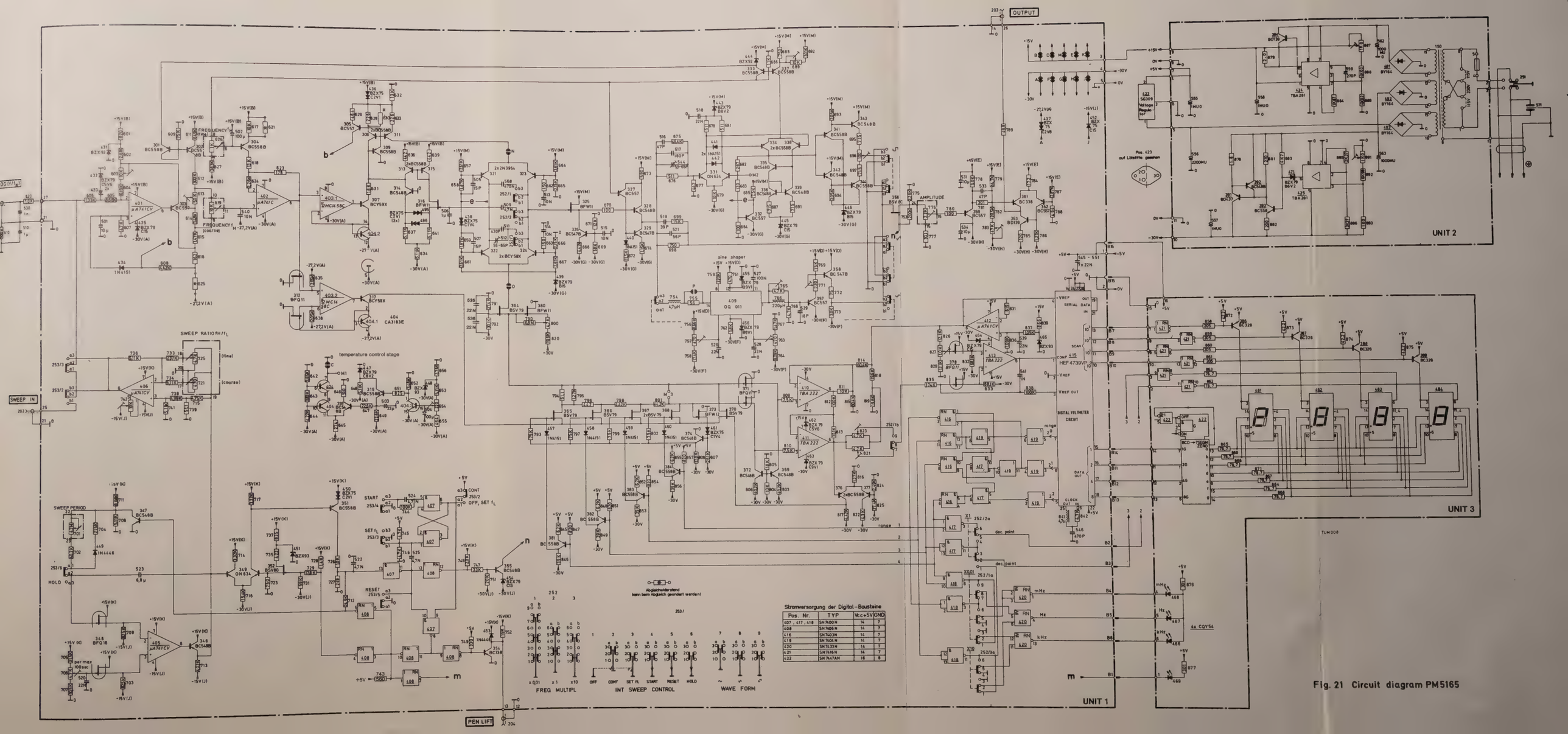



Fig. 20. Printed wiring board unit 3


OUTPUT
UNIT 1
UNIT 2
UNIT 3
SWEEP IN
PEN LIFT
SWEEP RATIO fH/fL
SWEEP PERIOD
HOLD
temperature control stage
sine shaper
AMPLITUDE
FREQUENCY f (coarse)
FREQUENCY f (fine)
SERIAL DATA IN
SERIAL DATA OUT
DIGITAL VOLTMETER CIRCUIT
HEF 4739VP
Stromversorgung der Digital-Bausteine
Pos. Nr. | TYP | Vcc+5V | GND
407 , 417 , 418 | SN 7400 N | 14 | 7
408 | SN 7408 N | 14 | 7
416 | SN 7403 N | 14 | 7
418 | SN 7404 N | 14 | 7
420 | SN 74 33 N | 14 | 7
421 | SN 7416 N | 14 | 7
422 | SN 74 47 AN | 16 | 8
FREQ. MULTIPL
INT SWEEP CONTROL
WAVE FORM
Fig. 21 Circuit diagram PM5165

## CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

**(excl. potentiometric recorders)**

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

| ① Country | ② Day Month Year | ③ Typenumber /Version | ④ Factory/Serial no. |
|---|---|---|---|
| 32 | 150475 | OPM 3260 02 | DO 0 0 7 8 3 |

*CODED FAILURE DESCRIPTION* ⑥

| ⑤ Nature of call | Location | Component/sequence no. | Category |
|---|---|---|---|
| ☐ Installation | | TS 0 6 0 7 | 5 |
| ☐ Pre sale repair | | R 0 0 6 3 1 | 2 |
| ☐ Preventive maintenance | 0 0 2 1 | 9 9 0 0 0 1 | 4 |
| ☒ Corrective maintenance | | | |
| ☐ Other | | | |

⑦ *Job completed* ☒

*Working time* ⑧ ☐☐12 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 32 = Switzerland

②Day Month Year 150475 = 15 April 1975

③Type number/Version OPM3260 02 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number DO 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

*Location*

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

*Component/sequence no.*

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

*Category*

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐12 = 1,2 working hours (1 h 12 min.)

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T&M/790601

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Now you are the user of a Philips test and measuring instrument. We trust that it will give you many years of faithful service. But we would like you to realize one thing: we can only supply the best in T & M equipment with **your** help, user.

We need to know what you have found to be the strong and weak points of this instrument; and we would be very interested to hear about any unusual or elegant applications you have devised for it. Some of this information can be passed on to our design and development departments; and some may be fed back to other users via our bimonthly publication **T & M News**.

May we therefore suggest that you fill in the reply card alongside and send it back to us right now. (or, - even better - make a note in your diary to fill in the reply card in say 6 months. After you have gained some experience in using the instrument in practice). That way, you'll be helping to provide the positive feedback we need to help you!

All contributions that are published will be paid for at current rates; while as an inducement for you to fill in the reply card, we are offering a free subscription to T & M News or a free copy of Part I of our Digital Instrument Course to all who reply.

## Erfahrungsaustausch

Meßgeräte müssen sich in der Praxis bewähren und die in sie gesteckten Erwartungen erfüllen; auch bei Ihnen, dem Besitzer eines Geräts aus der Serie der Philips Test- und Meßgeräte. Wir aber können T & M-Geräte nur zu Ihrer vollen Zufriedenheit herstellen, wenn wir alle Ihre Wünsche kennen.

Deshalb interessiert uns Ihre Meinung über die guten und weniger guten Eigenschaften dieses Gerätes. Außerdem suchen wir Erfahrungen über ungewöhnliche oder neue Anwendungsmöglichkeiten. Vielleicht können Sie unseren Entwicklungs- und Konstruktionsabteilungen einen guten Wink geben; vielleicht können wir Ihre Erfahrungen aber auch in unserer Publikation Info-dienst (nur in Deutschland) veröffentlichen, damit auch andere Anwender davon profitieren können.

Deshalb möchten wir Sie bitten, die anhängende Antwortkarte auszufüllen und an uns zurückzusenden. (Entweder gleich oder -noch besser - machen Sie sich eine Notiz auf Ihrem Kalender und schicken die Karte in einem halben Jahr zurück, wenn Sie genügend praktische Erfahrungen mit dem Gerät gesammelt haben). Damit helfen Sie uns, und wir können Ihnen helfen!

Alle veröffentlichten Beiträge werden dem üblichen Tariff entsprechend honoriert. Als Dank für das Ausfüllen der Antwortkarte bieten wir Ihnen ein Freiabonnement auf Info-dienst (nur in Deutschland) oder ein kostenloses Exemplar von Teil I von unserem Kursus Digital Instrument.

## L'intérêt du "feedback"

Vous voilà possesseur d'un instrument d'essai et de mesure Philips. Nous espérons qu'il vous donnera de nombreuses années de bons et loyaux services, mais nous voudrions attirer votre attention sur un point: ce n'est qu'avec **votre** aide que nous pouvons fournir des matériels d'essai et de mesure de toute première qualité.

Nous avons besoin de savoir quels en sont les points forts et les points faibles que vous avez découverts et nous serions très intéressés d'apprendre quelles applications inhabituelles ou élégantes vous lui avez trouvé. Certains de ces renseignements peuvent être transmis utilement à nos bureaux d'études; certains autres peuvent être communiqués à d'autres utilisateurs par l'intermédiaire de notre publication **T & M News** (édition française seulement en France).

C'est pourquoi nous vous serions reconnaissants de remplir la carte-réponse à côté et de nous la renvoyer (ou, mieux encore, de noter dans votre agenda que vous devez remplir la carte-réponse dans, mettons, six mois, une fois que vous aurez acquis quelque expérience pratique de l'utilisation de l'instrument). De cette façon, vous contriburez à nous fournir le "feedback" dont nous avons besoin pour mieux vous servir!

Toutes les réponses publiées seront payées conformément aux tarifs en vigueur; pour vous inciter à remplir la carte-réponse, nous offrons un abonnement gratuit à T & M News ou un exemplaire gratuit de la première partie de notre cours sur les instruments numériques à tous ceux qui répondront.

**Details of user:** **Persönliche Angaben:** **Expéditeur:**

Company/
Firma/Société .....
Department/
Abteilung/Service .....
Street/Straße/Rue .....
Box/Postfach/Boîte Postale .....
City/Stadt/Ville .....
Country/Land/Pays .....
Name/Name/Nom .....
Phone/Telefon/Numéro de téléphone .....

**Details of instruments:** **Gerätedaten:** **Instrument:**

Name/Name/
Désignation .....
Type number/Typennummer/
Numéro de type .....
Serial number/Seriennummer/
Numéro de série .....
Date purchased/Kaufdatum/
Date d'achat .....

What are the main applications for which you use this instrument?
Wofür verwenden Sie dieses Gerät hauptsächlich?
Quelles sont les principales utilisations auxquelles vous affectez cet instrument?

.....
.....

Please, list what you consider to be the **strong points** and the **weak points** of the instrument.
Zählen Sie bitte auf, was Ihrer Meinung nach die **guten Seiten** und was die **schwachen Stellen** dieses Geräts sind.
Veuillez énumérer ce que vous considérez être les **points forts** et les **points faibles** de l'instrument.

.....
.....
.....

Do you have any queries about the use of this instrument? If so, what?
Haben Sie irgendwelche Fragen über die Anwendung dieses Geräts? Wenn ja, welche?
Avez-vous des questions à poser sur l'emploi de l'instrument? Si oui, lesquelles?

.....
.....
.....

I have devised an interesting application for this instrument.

- ☐ I enclose a brief description (up to about 500 words) of this application
- ☐ Please send a representative to collect information about the application

Ich habe einen interessanten Verwendungszweck für dieses Gerät gefunden.

- ☐ Eine kurze Beschreibung hiervon (max. ca. 500 Wörter) erhalten Sie anliegend.
- ☐ Senden Sie bitte jemanden, der sich an Ort und Stelle über den Verwendungszweck informieren kann.

J'ai trouvé une application intéressante pour cet instrument

- ☐ Je joins une brève description (500 mots environ au maximum) de cette application.
- ☐ Veuillez envoyer un représentant à qui nous donnerons des renseignements sur l'application.

- ☐ I would like to receive **T & M News** regularly.
- ☐ Please send me Digital Instrument Course Part I.
- ☐ Ich möchte Info-dienst regelmäßig beziehen.
- ☐ Senden Sie mir Digital Instrument Course, Teil I.
- ☐ J'aimerai recevoir **T & M News** régulièrement.
- ☐ Envoyez moi la première partie du cours sur les instruments numériques.

PHILIPS

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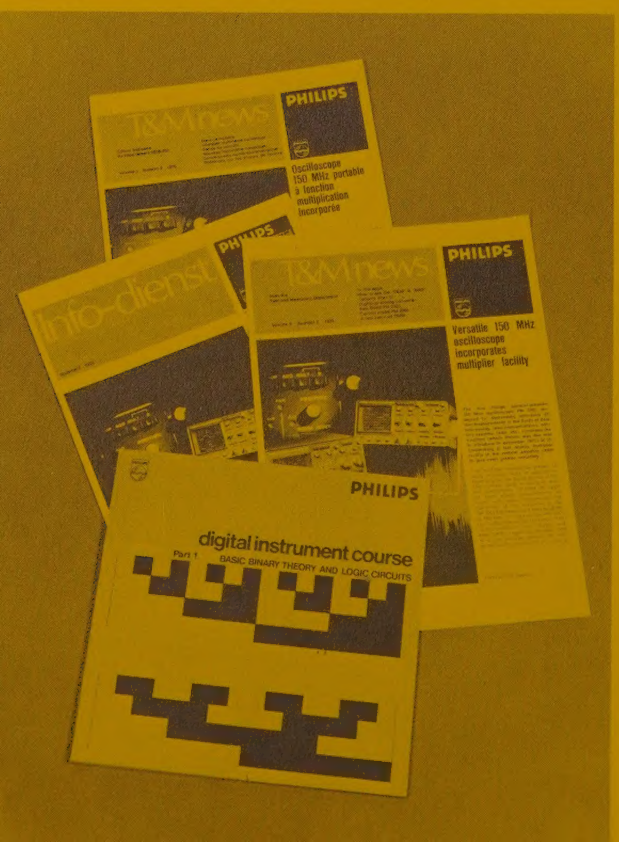
S & I TQ III - 2
Test and Measuring Instruments Department
Att. Mr. T. Sudar
EINDHOVEN
The Netherlands

please fold




## T & M News is your feedback unit

**T & M News** is a bimonthly publication issued by the T & M Measuring Department of Philips' Science & Industry Division, for distribution to actual and potential users of Philips' T & M equipment. It provides an effective means of exchanging information in the T & M field - both from the manufacturer to the customer and **vice versa.**

Apart from T & M **News** itself, we also issue **T & M News Reports,** which provide a vehicle for (generally longer) articles of a more specialized and/or theoretical nature to supplement the information given in **T & M News.** These Reports, being of a more specialized interest, are generally sent to a more restricted group of users; though anyone who is interested can obtain them on request.

One special series that was brought out in supplements to T & M News our Digital Instrument Course (Part I: Basic binary theory and logic circuits; Part II: Digital counters and timers; Part III: Digital voltmeters and multimeters; Part IV: IEC Bus Interface), which proved so popular with readers that each part of the course has been re-issued in booklet form.

## Info-dienst für Ihren Erfahrungsaustausch

Info-dienst (nur in Deutschland) ist eine Publikation der Philips GmbH Unternehmensbereich für Elektronik für Wissenschaft und Industrie für die jetzigen Besitzer und potentiellen Kunden von Philips T & M-Geräten. Dieses Blatt strebt einen effektieven Informationsaustausch auf dem T & M-Gebiet zwischen Hersteller und Anwender sowie **umgekehrt** an.

Neben diesen Info-dienst geben wir auch die **T & M News Reports** heraus (nur in englischer Sprache), in denen (im allgemeinen längere) Artikel mehr spezieller bzw. theoretischer Art als Ergänzung zu den Informationen in Info-dienst stehen. Diese Reports, an denen in allgemeinen nur Spezialisten interessiert sind, werden an eine begrenzte Anwendergruppe verteilt. Jeder, der daran interessiert ist, kann sie auf Anfrage erhalten.

Eine spezielle Serie, die gerade in den T & M News Supplements erschienen ist, war unser Digital Instrument Course (Teil I: Basic binary theory and logic circuits; Teil II: Digital counters and timers; Teil III: Digital voltmeters and multimeters; Teil IV: IEC Bus Interface). Diese Serie war bei den Lesern so populär, daß jeder Teil von diesem Kursus auch in Buchform herausgegeben wurde (nur in englischer Sprache).

## T & M News est notre moyen de communiquer mutuellement

**T & M News** est une publication de département de Mesure de Philips, destinée aux utilisateurs effectifs et un puissance d'appareils d'essai et de mesure Philips. Elle constitue un moyen efficace de transmettre de l'information dans ce domaine, aussi bien du fabricant vers le client que **vice versa.**

A part la publication **T & M News proprement dite,** nous diffusons les **T & M News Reports** (seulement en anglais) qui contiennent des articles (généralement plus longs) de nature plus spécialisée ou plus théorique, destinés à compléter l'information donnée dans **T & M News.** Etant donné leur nature, ces Reports ne sont généralement envoyés qu'à un cercle plus restreint d'utilisateurs; toutefois, quiconque s'y intéresse peut les obtenir sur demande.

Nous venons de publier dans les T & M News Supplements une série spéciale d'articles qui constituent un cours sur les instruments numériques (1ère partie: Théorie binaire de base et circuits logiques; 2ème partie: Compteurs numériques et minuteries; 3ème partie: voltmètres et multimètres numériques; 4ème partie: IEC Bus Interface) qui a rencontré un tel succés auprès des lecteurs que chaque partie du cours a été réimprimée sous forme de livret (seulement en anglais).

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